ROYAL BC MUSEUM HANDBOOK

Amphibians and Reptiles of British Columbia

Brent M. Matsuda, David M. Green and
Patrick T. Gregory

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ROYAL BC MUSEUM
Victoria, Canada

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PREFACE

In 1943 and 1944, G. Clifford Carl wrote and published two small books, *The Amphibians of British Columbia* and *The Reptiles of British Columbia*, numbers 2 and 3 of the British Columbia Provincial Museum's Handbook series. In the next 20 years both handbooks were reprinted several times. Many in British Columbia grew up with these and other handbooks by Carl; our worn copies are dog-eared and our pencilled comments litter their pages. In 1984, two of us wrote new, updated and re-illustrated successors to Carl's handbooks: *Reptiles of British Columbia* by P.T. Gregory and R.W. Campbell appeared as Handbook 44 in the series and *Amphibians of British Columbia* by D.M. Green and R.W. Campbell came out as Handbook 45. Both handbooks incorporated much of the information in Carl's earlier works with more up-to-date results of herpetological research from the intervening 40 years. Both of these books were reprinted several times.

Since 1984, the amount of information about British Columbia's amphibians and reptiles has increased at an enormous rate, demanding not just new editions of the previous handbooks but another, different handbook. Accordingly, we have amalgamated the 1984 handbooks and augmented them with new information, photographs and some new illustrations. The result you see here is a non-technical guide to the biology and identification of both the amphibians and the reptiles of British Columbia.

This book has two major sections. The first explores the general biology of amphibians and reptiles, with references to some species from around the world but emphasizing those that live in British

Columbia. We discuss many aspects of their fossil history, distribution and habitats, anatomy and physiology, behaviour and development, and relationships with humans.

The second section contains detailed accounts of each species that occurs in British Columbia. The accounts cover native species and introduced species that have established breeding populations in the province; other introduced species are discussed in a separate section following the species accounts. Each account describes the species, highlighting distinguishing features, and gives information on its life history, behaviour, habitat and distribution.

INTRODUCTION

Amphibians and reptiles are vertebrates – animals with backbones. Vertebrates, on the whole, are the most familiar animals to people, because they are often large and conspicuous, economically important, and intuitively understandable, simply because we ourselves are vertebrates. We rely on vertebrates as the major source of protein for our diet, and we surround ourselves with other vertebrates, in the form of pets and work animals. Vertebrates have an internal skeleton of bone (or sometimes cartilage), which enables the movement of body parts using muscles, and also provides support for the body and protection for internal organs. The backbone elements, called vertebrae, and the skull, are present in all vertebrates. Vertebrates that are not fish are called tetrapods, which means "four-footed". Even though many amphibians, reptiles, birds and mammals have returned to an aquatic existence or lost their limbs, they are still tetrapods because of their ancestry.

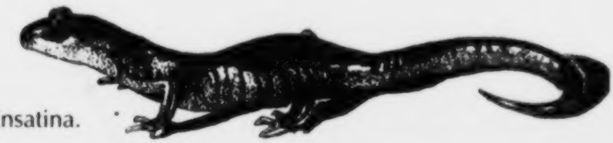
The study of reptiles and amphibians is called herpetology. The word is derived from the Greek *erpeton*, which means "a creeping thing" (an apt description of amphibians and reptiles), and *logos*, which is "study". Herpetology, then, is the study of creeping things, and biologists who engage in this practice are known as herpetologists. Although we have based most of our knowledge about the natural history and habits of the amphibians and reptiles in British Columbia on information gathered elsewhere, we are learning a great deal about these animals and their adaptations specific to the habitats of this province. There is ample room for more study on our amphibians and reptiles.

Amphibians and reptiles are diverse groups that differ from each other in many ways. From an evolutionary perspective, dealing with these groups together is completely artificial. Based upon evolutionary history (phylogeny), we now know that the Class Reptilia does not include all organisms that share a common reptilian ancestor. It includes the dinosaurs and other extinct Mesozoic vertebrates, but does not include birds, clearly the living descendants of the dinosaurs. Indeed, it is more and more common for scientists to speak of birds as dinosaurs, which makes them reptiles, every bit as much as snakes, turtles and crocodiles. But modern birds are also so clearly different from modern reptiles that scientists now divide reptiles into avian and non-avian, birds being the avian reptiles. In this book, we discuss only the living non-avian reptiles – the reptiles in the more traditional sense.

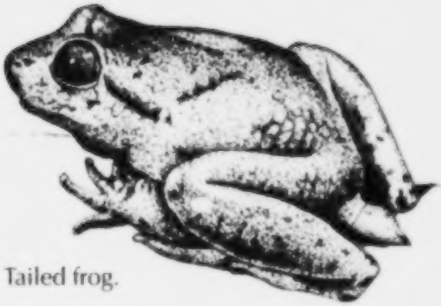
Amphibians

Amphibians comprise the class of tetrapod vertebrate animals with glandular skin that lacks epidermal coverings such as fur, scales or feathers. The nearly 5800 species of living amphibians are classified into three orders. The Anura (frogs and toads), with more than 5000 species, live all around the world except for the Antarctic and remote oceanic islands. The Caudata (salamanders and newts), with some 500 species, occur mainly in the Northern Hemisphere. The tropical Gymnophiona (caecilians) consists of about 165 species. New species of amphibians, mainly frogs, are discovered each year. Of the 46 species of amphibians known to occur in Canada, 22 can be found in British Columbia. These include 13 species of frogs and toads, and 9 species of salamanders and newts.

The three orders of amphibians are distinctive. To most people, a frog is a frog – stout-bodied and big-eyed, with long hind legs for jumping and no tail. But an enormous amount of variety exists among the huge number of species of frogs and toads in the world.



Ensatina.

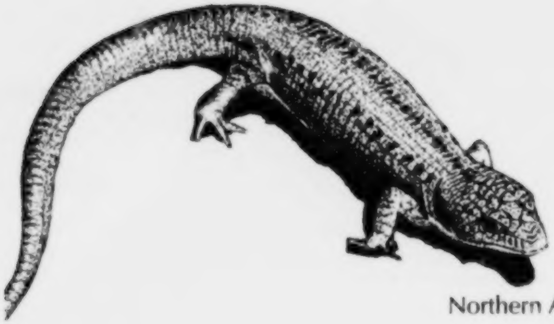


Tailed frog.

Superficially, salamanders resemble lizards, which are reptiles, but unlike lizards, salamanders do not have scales or claws on their toes. Also unlike lizards, salamanders can have aquatic larvae. The caecilians are worm-like, burrowing animals that have neither legs nor tails. They have minute, sometimes non-functional eyes buried under the skin of the head, and a unique sensory tentacle on either side of the head. Caecilians live only in the tropics and little is known about most species.

Amphibian means "double life", an appropriate name for these creatures that live both in water and on land. Throughout their lives, amphibians depend on water or moist conditions. Because of this, they are not as successful as reptiles at inhabiting arid habitats, but they excel when conditions are more to their advantage. They can be extremely abundant and a major component of many terrestrial ecosystems. As they are able to both respire and draw water through their thin, moist skin, amphibians can prosper in a variety of moist microhabitats, such as stream sides, ponds and forest litter, and take advantage of moisture even when burrowing underground.

Amphibians fertilize their eggs either externally or internally (outside or inside the body of the female). The males of most frogs and toads expel their sperm over the eggs as the female lays them; the tailed frogs are the only two species in British Columbia whose males possess a copulatory organ. Male caecilians have a copulatory organ, called the phallodeum. Most salamanders practise internal fertilization but do so by means of a sperm capsule, called a spermatophore, which the male lays and the female picks up.



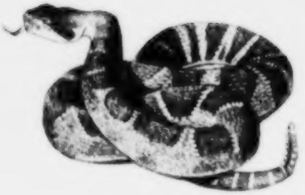
Northern Alligator Lizard.

Reptiles

Present-day non-avian reptiles number almost 8000 species worldwide, including about 4500 lizards, 3000 snakes, 300 turtles, 160 amphisbaenians (mostly limbless burrowing animals), 23 crocodilians (crocodiles, alligators and the gavial) and 2 lizard-like tuataras in New Zealand. Most reptile species live in the tropics and subtropics. Canada has only 44 species of turtles, lizards and snakes, with 16 native species in British Columbia (9 snakes, 4 turtles and 3 lizards). None of our species lives exclusively in Canada – all of them also occur in the United States. British Columbia has a relatively rich diversity of reptiles compared to other parts of Canada, with only Ontario and Quebec having more species. One of the major reasons for British Columbia's diverse reptile fauna is the tremendous variety of habitats available throughout the province, from the hot, dry interior to the coastal rainforests to the marine environment. Species here have adapted to particular habitats within this broad spectrum.

Reptiles, like birds and mammals, are mainly terrestrial animals, breathing by means of lungs and free from the necessity of being near or in water for breeding and other functions. Even highly aquatic reptiles such as the marine turtles and sea snakes have many of the features that have allowed reptiles to become truly terrestrial. Most amphibians are not liberated in this way and although some have less dependence on water, they have not been as successful in invading the world's driest habitats as have reptiles, birds and mammals.

In reptiles, males fertilize eggs with sperm internally (within the body of the female). Except in New Zealand's tuataras, male reptiles have a copulatory organ: turtles and crocodilians have a single penis, but lizards and snakes possess a pair, called hemipenes, although they use only one hemipenis at a time. Tuataras mate by cloacal contact between the two sexes, as do most birds.



Western Rattlesnake.

Fossil History

Amphibians are ancient. Their fossil record goes back some 350 million years to the Middle Devonian Period. At that time, amphibians were the only vertebrates living on land. The first amphibians were large and fish-like. They could breathe air and had rayed tail fins, as do fish, but their legs had fully developed toes.

In the Late Carboniferous Period, about 300 million years ago, amphibians diversified. Some were tiny and others grew to massive sizes. Early amphibians declined in numbers after the Carboniferous Period and all of them became extinct during the subsequent Mesozoic Era, the age of dinosaurs.

The possible links between ancient and modern amphibians are difficult to ascertain. The meagre fossil evidence provides only a glimpse of the early history of the modern frogs, salamanders and caecilians, but these groups have an ancient history. The oldest known fossil proto-frogs are from the Triassic Period in the Mesozoic Era, about 200 million years ago. *Triadobatrachus* had a longer body and shorter legs than modern frogs, as well as a small tail, but it was clearly terrestrial and frog-like. Frogs that were similar to some primitive frogs living today are known from the Jurassic and Cretaceous periods. Fossil frogs known from about 180 million years ago, the time of the Jurassic Period, show many similarities to our own tailed frogs (*Ascaphus*). The earliest salamander fossils date back to the Middle Jurassic Period. Some present-day genera of newts have been found as fossils in rocks dating as far back as the Eocene Epoch, 50 million years ago. *Eocaecilia,* the oldest caecilian, was recently described from Jurassic-aged deposits in Arizona. Unlike modern caecilians, it has small but complete front and hind limbs.

All present-day amphibians have a highly modified skeleton. Many of the bones are small or fused together or remain cartilaginous throughout life. These small, soft, delicate skeletons do not fossilize easily and are frequently overlooked. Fossils of modern types of amphibians are therefore rare and we will probably never have a complete record of their history.

The oldest reptile fossil dates back about 350 million years. As a group, reptiles reached their peak about 180 million years ago, when they were the dominant vertebrates, included now-extinct forms such as dinosaurs, plesiosaurs and ichthyosaurs (both large aquatic reptiles) and pterosaurs (flying reptiles). Most species and major categories of reptiles that have ever existed are now extinct. The two species of tuataras of New Zealand are the last representatives of a formerly more widespread group that co-existed with the dinosaurs. Lizards and, especially, snakes are the most recently evolved of our present-day reptiles, both having diversified in much the same time period as the mammals. The oldest known lizard fossils date back to the Triassic Period. The oldest fossil snakes, such as *Pachyrachis* and *Denilysia*, are Cretaceous in age.

Distribution

The worldwide distribution of amphibians and reptiles owes much to the consequences of continental drift. Most of the present major families of amphibians arose during the Mesozoic Era, about 245 to 65 million years ago. At the beginning of the Mesozoic, the continents as we know them all belonged to a single supercontinent known as Pangaea. During the Jurassic Period, this great land mass split apart. At first, Pangaea fractured into northern and southern continents called, respectively, Laurasia and Gondwanaland. Later, in the Cretaceous Period, these split into the continents of today.

Each of these landmasses carried a contingent of amphibians and reptiles, as well as other living things. Consequently, it seems that the caecilians, which are distributed across the globe but are restricted to the tropics, were once inhabitants of Gondwanaland, the southern continent that split apart into South America, Africa, Australia and India. The salamanders appear to be Laurasian as they are now distributed across the northern continents of Asia, Europe and North America and dispersed to the tropics only in two places. There are salamandrid salamanders (i.e., belonging to the family Salamandridae) in Southeast Asia and plethodontid salamanders distributed throughout Central America to northern South America. Frogs and toads are more widely distributed than the other two living orders of amphibians and had probably spread all over Pangaea before the great continental break-up. Today there are distinctly northern families of frogs, such as the spadefoot toads and their relatives in Europe, and there are southern families of frogs, such as the leptodactylids of South America, Africa and Australia. Some frog families like the bufonid toads, ranid frogs and hylid treefrogs are virtually cosmopolitan.

Like the amphibians, all the major groups of modern reptiles have fossil histories going back to the Mesozoic and their present-day distributions were influenced by much the same forces. Three groups of living reptiles are very old: turtles, crocodilians and tuataras. Except for high latitudes and altitudes, turtles occur nearly worldwide, including the oceans. But the two main groups of turtles have different distributions: the side-necked turtles (Pleurodira) inhabit tropical and subtropical parts of the southern hemisphere; the other turtles (Cryptodira) occur in temperate-to-tropical parts of all habitable continents except Australia, and in the oceans. Within these two major groups exist several taxonomic families that each have their own distinct geographic range. Crocodilians and tuataras were once widespread, with more species in the distant past than exist now. Only two species of tuatara currently occur on about 30 small islands off New Zealand, whereas crocodilians, which still occur on every continent except Europe and Antarctica, are restricted to the tropics and subtropics.

By far the majority of modern reptiles belong to the squamates (lizards, worm lizards and snakes). Lizards and snakes are widely distributed around the globe and absent only from very cold places at high latitudes and altitudes. Lizards can be found even on remote islands in the Pacific Ocean, where snakes are usually absent (except for sea snakes). Of course, families of lizards and snakes are not equally widespread or evenly distributed around the world. For example, skinks (family Scincidae) and non-venomous snakes can be found throughout most of the world, but the venomous beaded lizards of southwestern North America (Helodermatidae) are restricted to a relatively small area. Some squamate families inhabit the tropics only, and others extend into the temperate zones, but none live only in the temperate-zone. Iguanian lizards (Iguanidae and related families) are found only in the New World, Fiji and Madagascar, whereas their ecological counterparts, occupying similar habitats in the Old World, are members of the family Agamidae. The worm lizards (amphisbaenians) live in the tropics and subtropics, but not in Asia or Australia.

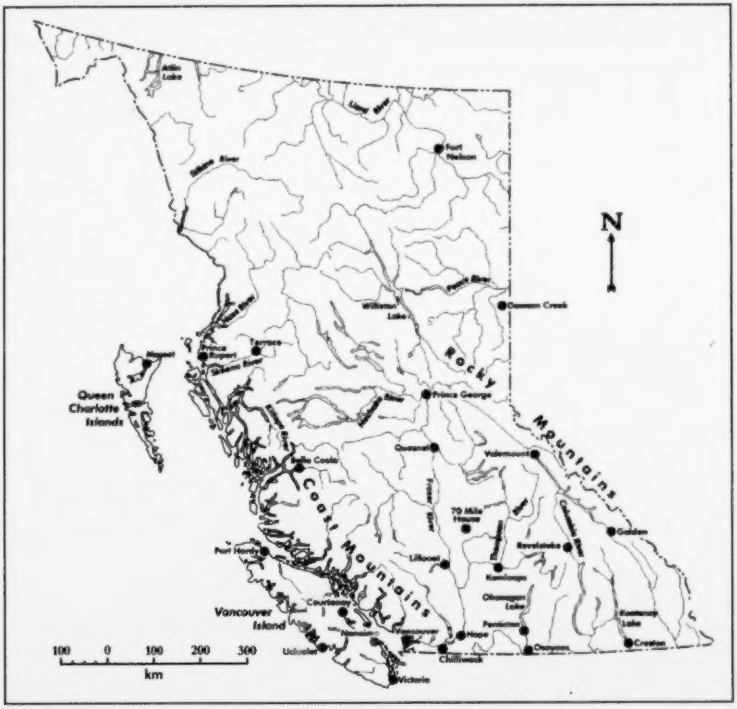
Amphibians and reptiles are most abundant in the tropics and subtropics of the world, becoming less abundant towards the poles. For example, about 300 species of reptiles occur in Mexico, 20 in Washington, 18 in British Columbia and only 1 in the Northwest Territories and Alaska. The same trend is true of amphibians. Although British Columbia has 19 native species of amphibians, only 2 of them reach the Yukon and 3 the Northwest Territories. There is less information about distributions in other parts of the world, particularly in the southern hemisphere, but the same trends occur elsewhere. Antarctica is the only continent with no living reptiles or amphibians, only fossils.

The world's larger reptiles such as crocodilians, most sea turtles, giant tortoises, the larger boas and pythons, and the monitor lizards, including the world's largest lizard, the Komodo Dragon *(Varanus komodoensis)*, are restricted to warm, less variable, tropical climates. The largest frogs and toads, like the Goliath Frog (*Conraua goliath*) of Africa and Blomberg's Toad (*Bufo blombergi*) of South America, are also tropical. There are at least two reasons why there are fewer large species of amphibians and reptiles further from the equator. Both relate to the inability of amphibians and reptiles to generate their own body heat, unlike birds and mammals; they must obtain heat from their surroundings. Large animals, which have relatively small surface-area-to-volume ratios, do not exchange heat with the environment as rapidly as small animals do. This means that re-warming after a cold spell can be difficult for them, thereby confining such animals to consistently warm areas. And due to their size, large reptiles have difficulty finding warm microhabitats in cold conditions, including the critical winter period when it is necessary to find a hibernating site below the frost line. This can be particularly important because terrestrial reptiles are unable to migrate long distances to avoid winter conditions as do many birds.

These restrictions are less important for aquatic reptiles and amphibians since the water is thermally more stable than terrestrial environments. For example, the world's largest salamanders are the totally aquatic Chinese Giant Salamander and Japanese Giant Salamander (*Andrias davidianus* and *A. japonicus*). Some sea turtles can travel long distances, so while they breed only in the tropics and subtropics, they occasionally venture into temperate-zone and even subarctic waters during the warmer months of the year or during El Niño years.

The world's most northerly amphibians cross the Arctic Circle: the Wood Frog in the Yukon and Alaska; the Great Crested Newt (*Triturus cristatus*), Common Frog (*Rana temporaria*) and Common Toad (*Bufo bufo*) in Scandinavia, where several more species come close the Arctic Circle; and the Siberian Newt (*Salamandrella keyserlingii*), Moor Frog (*R. arvalis*) and Siberian Wood Frog (*R. amurensis*) in northern Russia. Only two reptiles are known to occur regularly above the Arctic Circle, the Viviparous Lizard (*Lacerta vivipara*) in Eurasia and the Northern Viper (*Vipera berus*) in Scandinavia, although two other species approach the Arctic Circle in that part of the world. All the northernmost reptiles are either lizards or snakes. A high proportion of these species are also live bearers, not egg layers, including the northernmost ranging reptile in North America, the Common Garter Snake. Both the Leatherback Sea Turtle and Green Turtle have been recorded in ocean waters within the Arctic Circle. In British Columbia, the Common Garter Snake and the Western Garter Snake occur the furthest north of all our reptiles, whereas the Wood Frog, Columbia Spotted Frog, Western Toad, Boreal Chorus Frog, Northern Leopard Frog and Rough-skinned Newt all cross 60° north latitude. None of our amphibians bear live young, but all have great resistance to cold.

The precise distributions of amphibians and reptiles now found in British Columbia are more related to events of the recent past than to continental drift. The amphibians and reptiles of British Columbia are generally at, or near, the northern limits of their ranges and all of them probably invaded the province well after the close of the most recent ice age, 8000 to 10,000 years ago. Some species, such as the Rough-skinned Newt, Red-legged Frog, Northwestern Salamander, and Northwestern Garter Snake moved up the Pacific coast and did not cross over the Coast Mountains into the interior. Tailed frog populations resulted from northward migrations from founding populations in the American coastal mountains in the west and the Rocky Mountains in the east. Other species more adapted to arid conditions, such as the Tiger Salamander, Great Basin Spadefoot Toad, Gopher Snake, Racer and Western Rattlesnake, entered the province through the interior valleys. The Wood Frog, Northern Leopard Frog, and Boreal Chorus Frog, entered the province from east of the Rocky Mountains. The spread of some widely distributed species such as the Western Toad, Columbia Spotted Frog, and Western Garter Snake seems to


Atlin Lake
Liard River
Fort Nelson
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Peace River
Williston Lake
Dawson Creek
Masset
Prince Rupert
Terrace
Skeena River
Queen Charlotte Islands
Rocky Mountains
Prince George
Quesnel
Valemount
Bella Coola
Coast Mountains
Fraser River
70 Mile House
Golden
Revelstoke
Port Hardy
Lillooet
Kamloops
Okanagan Lake
Courtenay
Vancouver Island
Nanaimo
Vancouver
Hope
Penticton
Kootenay Lake
Creston
Osoyoos
Chilliwack
Ucluelet
Victoria
100
0
100
200
300
km

General geographical features of British Columbia.

have been less affected by British Columbia's mountainous terrain, but these species are stopped by the colder climate of the far north. The geographic varieties of the Long-toed Salamander and Common Garter Snake suggest that these species may have entered the province separately through coastal, interior and eastern routes from the south.

Amphibians in Canada cannot withstand the salinity of seawater, so their distributions on the coastal islands of British Columbia are interesting. Hecate Strait, Johnstone Strait, the Strait of Georgia and Juan de Fuca Strait block the dispersal of most amphibians from the mainland. Only the Western Toad has managed to cross Hecate Strait without the help of humans to colonize the Queen Charlotte Islands. But several species live on Vancouver Island and many smaller islands near it, indicating that an overland connection to the mainland did exist after the ice retreated.

Seawater is less of a barrier to reptiles. Western Garter Snakes regularly forage along seashores at low tide, so their distribution on both sides of the Strait of Georgia is less surprising. Some reptiles, including the sea turtles, have adapted to an exclusively marine existence. Because of the salinity of the seawater, sea-going species must be able to excrete excess salts from the body; they do this through salt-secreting glands on the tongue or under the eyes. Sea turtles can range widely in all the world's warm ocean waters and thus have the largest geographic ranges of any reptiles.

Humans have also aided the spread of amphibians and reptiles. Pacific Treefrogs were deliberately introduced to the Queen Charlotte Islands. There is speculation that the Wandering Salamander may have found its way to Vancouver Island and several Gulf Islands in the late 1800s as a stowaway on oak-bark shipments from northern California to tanneries in southern British Columbia. Introduced Bullfrogs and Green Frogs, brought in by now-defunct frog farms as stock for the frog-leg market in the mid 1900s, have become well established throughout Greater Vancouver and southern Vancouver Island. Common Wall Lizards, of Italian origin, have established thriving populations near Victoria.

Locomotion

Walking is the most basic form of locomotion among terrestrial vertebrates. Most amphibians and reptiles have their legs splayed out to the side, rather than positioned underneath like those of mammals. Except for the rigid bodied frogs and turtles, amphibians and reptiles undulate their body laterally when they walk or run; they step forward with opposite front and hind legs, which, combined with a bend in the body, enables them to increase the length of their stride.

Most aquatic freshwater turtles have well-developed webbing between their toes, especially on the hind feet. They use their feet like paddles when they swim. Sea turtles, the most aquatic of turtles, have small shells for their size and modified wing-like forefeet or flippers. Most turtles have clawed feet, but sea turtles have only one or two claws on each flipper, except for the Leatherback Sea Turtle, which has no claws. When sea turtles swim they raise and lower their flippers like the wings of a penguin, rather than use them as paddles. Shaped like hydrofoils, the flippers generate lift and propulsion. The webbed hind feet of marine turtles are also flipper-like and used to steer. The most terrestrial turtles are the tortoises, which are almost incapable of swimming. Their hind feet are stumpy like an elephant's; most burrowing varieties have massive front limbs for digging.

Frogs specialize in jumping. Their long, muscular hind legs and long toes effectively launch them into the air. But there is more to successful jumping than the launch. The way in which the legs and pelvis articulate with the frog's spinal column is also important. The frog's spinal column is very short compared to that of other animals – there are only eight vertebrae in front of the sacrum (the vertebra where the hips attach). This short, rigid body is effectively a projectile thrust forward by the hind legs during a jump. Thrust transmits through the pelvis via elongated ilia, bones that project from the sacrum. In other animals, the ilia connect to the sacrum on the sides, but a frog's ilia connect underneath. This ensures that the force of the legs transmits upward through the sacrum, lifting the body up into the air as well as forward. When the frog comes down, its front legs and pectoral girdle absorb the shock of landing. Frogs always close their eyes as they leap.

Snakes move rapidly and easily without limbs. Terrestrial snakes have flat bellies with large, overlapping ventral scutes (scales) that provide maximum contact with the ground during locomotion. Terrestrial snakes exhibit five major kinds of locomotion, singly or in combination. The most common method is lateral undulation, in which the snake swings its body through a series of horizontal curves, pushing against irregularities in the ground at various points. In slide-pushing, usually employed on smooth surfaces where there is little to push against, the snake thrusts its body into wide bends pushing back against the ground along its length. Heavy-bodied species, such as the Western Rattlesnake, use rectilinear movement, passing waves of movement down the body. Each wave consists of a forward motion of the ventral scutes, that anchor the body to the ground, followed by a shift of that part of the body forward. This results in a straight-line motion; the snake's body does not bend. In tight places, snakes use concertina movement, contracting part of the body into a series of tight curves, anchoring the body and allowing the anterior end to move forward. Sidewinding is a specialized kind of locomotion used mainly by snakes on unstable ground, such as sand. It consists of a series of lateral looping movements with only two points of the body in contact with the ground. The result is a forward and sideways looping movement of the body. Sidewinding also reduces a desert snake's contact with the hot sand and helps prevent overheating. Many species of snakes can sidewind, not just desert snakes.

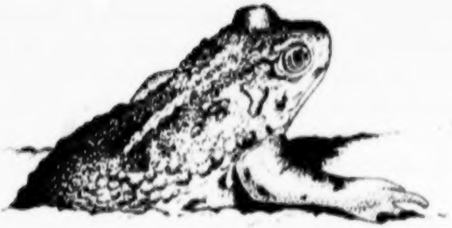
Few species rely on just one means of locomotion. Most snakes also can swim and some are able to make prolonged dives. Surface swimming is usually accomplished by lateral undulation. Specialized aquatic snakes, such as sea snakes, have a laterally flat tail to help propel them forward and valvular nostrils to keep water out while diving.

Skin

Without an external covering of scales, feathers or hair, the skin of an amphibian is exposed directly to the environment. Perhaps because of this, amphibian skin has developed into a complex, highly vascularized structure. Most amphibians do not drink water but absorb it through their skin. This ability allows desert amphibians to survive in intensely dry environments by burrowing beneath the surface to absorb soil moisture. Sea water, which is saltier than the amphibian's bodily fluids, reverses the process, causing it to dehydrate through its skin. Prolonged immersion in salt water will usually kill an amphibian. But some species of salamanders can survive brackish water by excreting highly concentrated urine, and some species of frogs, such as *Platymantis vitiensis* of Fiji, live and forage along the sea coast.

Respiratory gas exchange (the uptake of oxygen and the release of carbon dioxide) requires a moist, vascular membrane for the gases to diffuse. In most land-dwelling vertebrates, this occurs in the lungs. An amphibian pumps its throat to force air in and out of the lungs, because it does not have the internal diaphragm that mammals have. An amphibian also exchanges gas through the skin and the lining of its mouth. This enables it to hibernate under water in winter, receiving enough oxygen for respiration from the cold water through its skin without having to surface for air. The lungless salamanders (family Plethodontidae) have dispensed with lungs altogether and rely entirely upon respiration through the skin and lining of the mouth.

An amphibian must keep its skin moist to avoid desiccation and death. Accordingly, amphibians are rarely found far from moisture.



Great Basin Spadefoot Toad digging in.

Those that live in dry regions, like the Great Basin Spadefoot Toad, escape from drought by burrowing down into the ground to where the soil is moist. Amphibians also have a variety of skin glands that help keep the skin moist and help to protect them from enemies. They have two major types of skin glands: mucous and granular. Mucous glands are small and distributed all over the body; the pores where they open onto the skin are microscopic. These glands secrete fluid mucus that helps lubricate the skin and keep it from drying. They also secrete more mucus when the animal is stressed, making frogs and salamanders slippery and difficult for predators to capture or hold. Granular glands secrete poisons, and are descibed in Venoms and Toxins (pages 18-19).

Both amphibians and reptiles periodically shed the outermost layer of the skin as they grow. They shed the whole outer layer at once, in one piece or in large patches. Frogs and toads begin shedding by working the old skin layer off their backs with their legs. They use their mouths and front limbs to help pull it off the rest of the body and then generally swallow it. Salamanders and newts also tend to do this. The newly exposed skin is clean and bright.

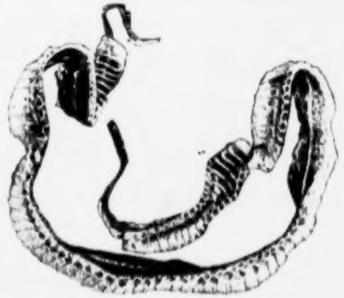
Reptilian skin is dry to the touch and almost completely without glands. The characteristic elements of a reptile's skin are its scales, thickened patches of keratin, formed by folds in the outer or epidermal layer of skin. The large scales on a turtle's shell are called scutes, as are the larger, more bony scales on a snake's head and belly. Reptiles, in general, tolerate much drier conditions than amphibians, but not because of the scales. Lipids in reptile skin make it more waterproof than amphibiàn skin. Terrestrial reptiles can further reduce water loss by producing concentrated urine. Unlike amphibians, reptiles do not exchange gases or absorb moisture through their skin.

The pattern of.scales in reptiles is complex and species-specific, but snakes tend to have less variable arrangements than lizards.

The scales on the head of lizards and snakes are similar, but the overlapping body scales of snakes are arranged in longitudinal rows on the back and sides. The number of these rows is an important feature in species identification. Body scales can be smooth or keeled, and sometimes pitted. The snake's ventral surface consists of a series of transverse, overlapping scales (ventral scales) with the posterior end of each scale being free. An anal plate (scute), located immediately in front of the anal opening, can be single or divided. The ventral surface of the tail consists of subcaudal scutes, in either a single row or two parallel rows, according to the family.

As a snake or lizard prepares to shed its skin, it grows a new layer underneath. The old skin layer loosens and the space between it and the new layer fills with fluid lymph, making the animal look temporarily dull and faded. Snakes have a clear scale, called a spectacle, covering the eye. As the process of loosening the old skin takes place, the spectacle becomes cloudy, blue-grey and dull. Snakes are often irritable at this time, because they cannot see clearly. When the spectacle clears again it signifies that the old skin layer is completely loosened, and that shedding will take place soon. The snake sheds by rubbing its snout against a rock or other object to loosen the skin. It then moves forward, peeling back the skin and leaving behind an inside-out cast, peeled off like a person removes a stocking. The skin usually comes off in one piece, including the spectacle, showing the details of every scale, although large snakes and lizards can fragment their skin more easily in the process. Snakes shed their skins periodically, the frequency depending upon a variety of factors, especially those affecting growth rate. Since snakes do not often feed during the time it takes to prepare and shed, they usually have a healthy appetite when the process is completed.

A vitally important aspect of skin colour and pigment patterns in amphibians and reptiles is the role that they play in camouflage by allowing the animal to blend in with its background. Several species of lizards, such as the Old World chameleons and the tropical New World anoles, which are often sold as chameleons in pet shops, and



Discarded snake skin.

many kinds of treefrogs, can change colour under certain circumstances. Chameleons are the masters of colour change, being capable of quite a range of colour and pattern. The anoles change mainly from dark brown to bright green. Grey Treefrogs (*Hyla versicolor*) found in eastern North America can change from pasty grey through bright green to a deep brownish green, and our native Pacific Treefrog can range from green to dark brown. Whatever colour the treefrog assumes, its pattern of contrasting markings remains the same and will be visible so long as the frog is not light or dark enough to obscure the pattern. None of British Columbia's native lizards can change colour.

It is logical to think that the ability to change colour would be most advantageous where the animal's colour matches its background, but this is not the only factor determining colour change. The animal's colour can also depend on its state of excitement, its health, its temperature and the light that falls upon it. Even lizards and frogs that cannot change colour can usually change shades, becoming lighter or darker, probably in response to light or temperature changes. Cooling tends to darken an animal and warming makes it lighter. The changes in colour or shade are a means of optimizing heat absorption under different conditions. Darker colours absorb solar radiation more readily, helping a cool animal warm up. Conversely, when an animal is hot, a lighter shade that better reflects radiation helps to keep it from overheating. These changes between light and dark are due to the dispersion of pigment granules of melanin in cells called melanophores, which are found in the dermis layer of the skin. When the melanin granules are concentrated in the centre of the cell, the animal's light colour can show through, but when the granules are dispersed throughout the cell, they block the underlying pigments from view and the animal becomes darker. The physiological control of this process is quite complex and can be hormonal or neural.

Venoms and Toxins

Amphibian skin has both granular and mucous glands. The granular glands are larger and located in discrete places on the upper surface of the body, tail and head. In non-poisonous species, the granular glands are small, but in poisonous species, they secrete

A toad's warts secrete toxic liquids.

substantial amounts of toxic and noxious substances. The warts and parotoid glands of toads are modified and specialized poison glands. The ridge on the tail of the Northwestern Salamander and the granular bumps on the skin of the Rough-skinned Newt are also poison glands. Amphibian poison glands usually produce a bitter, white, sticky fluid that is irritating to mucous membranes lining the nose and mouth. Some frog and salamander secretions can make you sneeze. Amphibian poisons range from the bitter but essentially harmless secretions of the Western Toad to the highly toxic poisons of some newts and tropical frogs such as the dart-poison frogs of Central and South America (family Dendrobatidae). The secretions themselves contain many amines and other nitrogen-containing compounds that, originally, might have been used as a means of excreting nitrogenous wastes. The noxious skin secretions of amphibians are purely for defence. The animal releases them only when it is extremely agitated, mainly in order to render itself a less-than-tasty meal. No amphibian has a poisonous bite and only a few can inflict a poisoned wound. Newts of the genera *Pleurodeles* from Europe and *Echinotriton* from southeast Asia have sharply pointed ribs that they can poke through the skin, right through their poison glands – with these they can wound a predator.

Venomous snakes can use their poisonous bite for defence, but the primary purpose of reptile venoms is to subdue and begin the digestion of prey. Snakes inject their victims with venom through modified teeth, called fangs, and then wait for their victims to die. They produce their venom in a modified salivary gland above the angle of the jaw. A duct connects the venom gland to a fang on each side. The type and mixture of venoms varies among species. All are chemically complex; some contain *neurotoxins*, the major component in cobra venoms, which mainly affect the nervous system, while others contain *hemotoxins*, characteristic of most rattlesnake venoms, which mainly affect the circulatory system and cause local tissue destruction. Many species have varying mixtures of these toxins and most venoms, therefore, have a combination of effects. In addition to killing the prey, an important function of envenomation is to speed up digestion, since snakes cannot chew their food to expose more of it to digestive juices.

Venomous snakes of the family Colubridae are rear-fanged snakes, so-named because their fangs are at the back of the tooth-bearing maxillary bone in the upper jaw. The Night Snake is the only rear-fanged snake in British Columbia. Rear-fanged snakes have grooved – not hollow – fangs, so that they cannot inject venom efficiently into a bite wound. The snake has to take the prey well into its mouth and sometimes use a chewing-like motion to envenomate it.

The fangs of front-fanged venomous snakes have closed canals (i.e., they are hollow, like hypodermic needles) and can inject venom deep into the victim's body with one quick strike. These snakes fall into two major groups. The group that includes cobras and sea snakes has fairly short fangs fixed in place at the front of the maxillary bone. The other group, the vipers and pit vipers (so-called because of the sensory pits on the head), also have fangs at the front of the mouth, but their fangs are very long and are folded back against the roof of the mouth when the mouth is closed. The Western Rattlesnake is British Columbia's only pit viper.

Snakes will also bite to defend themselves if they are unable to escape. Other defensive behaviours include hissing, vibrating the tail, voiding the scent glands at the base of the tail, feigning death, spreading a hood and rolling into a ball. Some species native to British Columbia exhibit several of these behaviours.

Senses

The sense of smell (olfaction) is intimately tied to the sense of taste, as both are chemical senses. In the lining of the mouth and nose are specialized cells and organs that are sensitive to particular chemicals. Airborne chemicals trigger our sense of smell; chemicals that touch our tongue trigger taste. This is also true of amphibians and reptiles, but in some ways the two senses are even more closely associated. Among salamanders and turtles, the sense of smell is very important. Smell is not only used for detecting food but also for detecting potential mates.

The nasolabial grooves of plethodontid salamanders, which run down from the nostril to the mouth, and often beyond the line of the mouth onto fleshy extensions called cirri, enable the salamander to pick up chemicals from the ground and transfer them to sensors in the nose. Salamanders are particularly adept at detecting other members of their own species, and salamanders usually nudge and appear to sniff each other to initiate courtship and mating behaviours. Classic experiments by V.C. Twitty in the 1950s and 1960s in California showed that Red-bellied Newts (*Taricha rivularis*) find the way back to their native streams, even from great distances away, using their sense of smell.

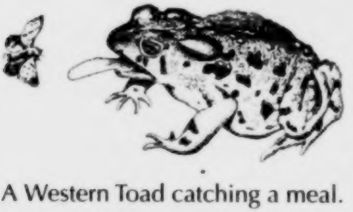
Snakes and lizards smell via the nostrils, but also sense chemicals using the tongue and a sensory structure on the roof of the mouth, called Jacobson's organ (or the vomeronasal organ). This sense, called vomerolfaction, is well-developed in snakes and the more important of their two chemical senses. When a snake flicks out its tongue, the two forks pick up chemicals in the air and on the ground. Retracting the tongue brings it into contact with Jacobson's organ, which detects the chemicals that the snake has picked up from the environment. Thus snakes smell (in a manner of speaking) with their tongues. Many lizards, including Northern Alligator Lizards in British Columbia, do the same, although their tongues may not be as slim or as forked as a snake's.

Most frogs have complex and highly sophisticated ears, which is understandable in animals that use calls to communicate with each other. Ears detect airborne vibrations, which we recognize as sounds. Airborne sound vibrations cause the tympanum (eardrum) of the outer ear to vibrate. These vibrations are transmitted by small bones in the middle ear to a fluid-filled inner ear. Within the inner ear are hair cells, tuned to particular sound frequencies, which have extensions that bend to specific vibrations. When the hair of the hair cell bends, it sends a nerve impulse to the brain that is perceived as sound. While humans have this system, frog ears come with extras. A frog's tympanums are easily visible on the sides of its head. The stapes in the middle ear connects the tympanum to the oval window of the inner ear, but the frog's opercular bone also indirectly connects the inner ear to the shoulder blade. Low frequency, ground-borne vibrations can be transmitted through the frog's front legs via the shoulder blade to the inner ear. Within the frog's ear are two areas, called papillae, populated by hair cells that receive vibrations and translate them into nerve impulses. The basal papilla, like the cochlea of the mammalian ear, has hair cells tuned to sound frequencies above one kilohertz received via the tympanum; frogs also have papillae with hair cells tuned to low frequency vibrations, less than one kilohertz. They can thus listen to the ground using their feet; a frog can literally hear your footsteps as you approach it. Salamander ears also have this system.

Lizards hear well, but turtles apparently do not pick up airborne sounds well, despite having a complete auditory apparatus; instead, turtles detect ground vibrations. Snakes have incomplete ears, missing a tympanum and movable middle-ear bones, but they can detect low-frequency airborne sounds and vibrations through the ground; a snake's stapes are firmly attached to the lower jaw, not a tympanum, and so transmit low frequency vibrations from the jaw to the inner ears.

Aquatic amphibians such as larval salamanders and tadpoles possess a *lateral-line* system that is related to hearing. The lateral line has hair cells, just like those of the inner ear, but they are exposed to the surrounding water. They detect water-borne vibrations just as the inner ear hair cells detect vibrations in the fluid of the inner ear. Most fishes have a readily visible lateral line running along each side of the body to the jaws and snout, but in aquatic amphibians the lateral-line canals extend over the head and around the jaws as well as along the body. The lateral-line system is useless in the air, so amphibians usually lose it during metamorphosis.

The most important sense in most frogs and lizards is vision, which plays a prominent role in many aspects of their life history. Frogs are visual hunters, with well-developed motion detectors in the retinas of their eyes. Anything small and moving is usually perceived immediately as potential food. Frogs are also able to see colours, and can do so under very low light conditions. In the retina of the eye, there are two sorts of cells that detect light. Rod cells are highly sensitive to a large spectrum of light. This means that they have good vision at low light intensities and in the dark of night but cannot ordinarily detect different wavelengths of light. Different wavelengths represent different colours, so rods only allow vision in shades of grey. Many mammals, including Domestic Dogs (*Canis familiaris*) and Domestic Cats (*Felis sylvestris*), only have rods in the retinas of their eyes that enable them to see well at night, but prevent them from seeing



A Western Toad catching a meal.

colours. Cone cells of the retina are tuned to specific light frequencies: yellow, cyan or magenta. This restricted sensitivity means that they do not function well in the dark but they enable colour vision when there is enough light. For humans, colours do not disappear at night, but our ability to detect them does. Frogs, however, have a second kind of rod cell, called a *green rod* – in combination with the regular rod cells of the retina, it enables frogs to see some colours even in the dark of night.

Many lizards have well-developed, albeit conventional, colour vision. The ability to discriminate between different colours can be especially important in certain behavioural displays. In some species, such as the Western Skink, the males are more brightly coloured than the females during the breeding season. In addition to attracting females, these colours are probably related to the recognition of other males and the defence of territories.

Lizards detect prey by sight. Most lizards are insectivores or, more appropriately, generalized small-animal predators, and respond to the movements of their prey; they often ignore non-moving prey. Old World chameleons, which are slow-moving arboreal lizards, have bulging eyes that move independently and can swivel almost 180 degrees. When a chameleon locates prey, it brings both eyes around to focus stereoscopically. This is important since a chameleon catches its prey by firing its tongue at it and accurate aim is a necessity. The peculiar and distinctive turret-like housing of the eye also helps to determine range even without stereoscopic vision by restricting the eye's field of view. Lizards that run short distances at their prey have no need of such an elaborate visual apparatus, but still rely heavily on vision. Some lizards, including herbivorous species, use both vision and chemical senses to identify their food.

Most snakes do not appear to have particularly acute vision, but can detect movement at short distances. All snakes lack eyelids, but they have a clear scale, called a spectacle, covering the eye. Similarly, some lizards do not have eyelids, including the night lizards (family Xantusiidae) and geckos (family Gekkonidae). But unlike lizards, snakes lack the cilliary muscles in the eyes that change the shape of the lens to allow it to focus light on the retina. Instead, a rounder lens is shifted back and forth to focus, more like the eyes of a fish than another terrestrial vertebrate. Some burrowing snakes have vestigial eyes buried under the skin.

Turtles seem to have good colour vision. This ability to distinguish light of different wavelengths may be important for the hatchlings of aquatic turtles to enable them to go in the right direction towards the water upon emergence from the nest.

Tuataras and some lizards have a parietal or median eye on the top of the head, in the middle of the parietal scale. It has been implicated in the possible control of colour change and perhaps thermoregulation, but its exact function is not known. It is small and not capable of forming images, but it does seem to be able to detect light from dark.

Several species of snakes, including rattlesnakes, other pit vipers and many species of boas and pythons, possess heat-sensing organs on the head. The boas and pythons can have a series of pits running along the upper jaw and lower jaw, but the pit vipers have only two pits, one on either side of the face, between the eye and nostril. These snakes feed on warm-bodied prey and the pit organs allow them to detect their victim's body heat if the temperature differs from its surroundings. The pit organs of pit vipers have a thin membrane that divides an internal chamber from the outside air, allowing temperature differences to be detected. These organs are very sensitive and directional. A rattlesnake can locate and successfully strike warm-blooded prey even if blinded and unable to use its tongue.

Selected References: Twitty 1955, 1959; Twitty et al 1967a, b.

Defence

The first defence against predators for most amphibians and reptiles is to flee. Ranid frogs sit along the bank of a pond or stream and leap into the water when they feel threatened. Basking turtles drop into the water and swim away. Lizards run, snakes crawl and toads hop. Sometimes the animal's colour pattern helps disguise it, even as it escapes. A spotted or banded snake's markings blur to an apparently solid colour when the snake moves rapidly, which is confusing. Similarly, a frog can surprise a predator by revealing its bright belly and groin colours when it jumps. These confusing or surprising colours may cause the predator to hesitate just enough to allow the frog or snake to escape.

The most common and most direct action taken by lizards and snakes, at least when molested, is to bite. Both the Northern Alligator Lizard and Western Skink readily bite when captured. Biting is obviously the best means of defence for the sluggish, venomous lizards of the genus *Heloderma* of southwestern North America. Some lizards and turtles have a powerful bite that can inflict a severe injury. Small snakes will bite and their needle-sharp teeth can draw blood despite having a weaker jaw strength than that of a lizard or turtle. Venomous snakes will bite in self defence, with serious consequences. Frogs do not bite, except for the South American horned frogs (*Ceratophrys* and *Lepidobatrachus*). Most frogs have only tiny teeth, and toads have none at all. But when annoyed, *Ceratophrys* will gape its mouth, lunge and bite tenaciously. Some salamanders will try to bite if handled roughly, but a small salamander's jaws and teeth are not strong enough to hurt a human. The sharp claws of lizards and turtles can also be quite damaging to a potential predator. Some lizards, such as iguanas, will turn their body away from an attacker and start flailing their tails, lashing at the attacker as they begin to sprint away. Iguanas, monitors and tegu lizards can use their long, powerful tails like whips. The rather sharp scutes along the dorsal midline of the tail increase its effectiveness as a weapon.

Some horned lizards (*Phrynosoma*) of western North America exhibit a bizarre reaction to a predator's attack, although rarely – they squirt a stream of blood for one or two metres from a sinus in the corner of the eye. How this behaviour deters an attack is not clear, though squirting blood may simply distract a predator such as a Coyote (*Canis latrans*) or Domestic Dog (*C. familiaris*).

Another common scare tactic used by lizards and many frogs and toads, is to inflate the body and appear larger. Many reptiles combine this behaviour with a threatening stance and open mouth, exposing the bright colours of the tongue and mouth cavity. The same function can be attributed to the brightly coloured dewlap on the throat of many lizards. In addition to its colour, the dewlap increases the apparent size of the lizard's body when viewed from the side. When alarmed, the Chuckwalla *(Sauromalus obesus)* of the southwestern United States, retreats deep into a rocky crevice and inflates its lungs with air; wedged tightly in the crevice, the lizard is difficult to pry loose. Turtles use their shells as a refuge.

Toads routinely inflate themselves and rear up on their legs when confronted with a predator, such as a snake or a Raccoon (*Procyon lotor*). Even brushing a toad on the nose will induce this behaviour. Rearing up and lowering its head exposes the toad's most formidable defence: the parotoid glands behind its eyes and its warts, all of which contain a noxious poison. The highly toxic Rough-skinned Newt, rather than rearing up like a toad, flattens its back and raises its head to expose its bright-orange chin and belly, and waves its tail over its head.

If severely stressed, many lizards and salamanders can voluntarily drop all or part of the tail to distract a predator. Young Western Skinks have a brightly coloured tail that can be lost easily – its bright colour draws a predator's attention away from its head and body. The Ensatina actually waves its tail at a potential enemy. These tail-dropping species have a zone of weakness in the tail, allowing it to break cleanly there; the blood vessels at the break close up rapidly, limiting loss of blood. The severed tail continues wriggling, inviting the predator's attack and thus enabling the animal to escape.

Most species can grow back the lost part of the tail. A lizard's regrown tail usually differs in colour from the original and has smaller, more irregular scales. Salamanders possess even greater powers of regeneration, able to grow back all of their tail, lost toes or an entire limb, and the results are usually indistinguishable from the original appendages. Regeneration of extremities is a widespread phenomenon among vertebrate animals, at least in the early stages of development. An adult frog cannot re-grow a lost limb but a tadpole can. Even newborn mammals are capable of re-growing the last segment of a finger if it is lost in an accident. Salamanders are unusual in that they retain full regenerative abilities as adults.

The process of regeneration involves reorganization of the cells left in the stump. At first they regress into an embryonic-like condition. These cells then multiply and re-differentiate into the kinds of tissues that were lost. Initially, a bud (blastema) forms over the wound; then, as the tissues continue to re-differentiate, the new limb or tail develops. The process is still not completely understood. The growth of regenerating tissues has many similarities to the growth of cancers. The study of regeneration in salamanders is an important part of embryology and medical research.

Reproduction and Mating Behaviour

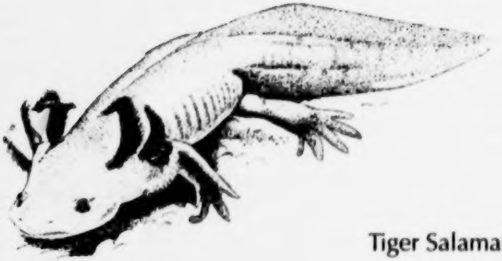
Amphibians and reptiles have an extremely varied range of reproductive strategies, and some possess highly complex social organizations. Many species of crocodilians, frogs and salamanders show elaborate parental care and protection of eggs and young. Some snakes, lizards and salamanders brood their eggs, and some species of frogs have unusual strategies to protect, raise and nurture their offspring. Territorial lizards and frogs show a high degree of social interaction, every bit as complex as that of birds, with elaborate means of communication.

Salamanders

All salamanders lay eggs, except for three species of European salamanders in the genus *Salamandra* that retain their eggs and give birth to live young. Primitive salamanders of the families Hynobiidae of Asia and Cryptobranchidae of Asia and North America fertilize their eggs externally, as do most frogs. But most newts and salamanders practice internal fertilization in an indirect and unusual manner. Male salamanders do not have copulatory organs and so cannot transfer sperm directly to the reproductive tracts of female salamanders. Instead, a male lays a small packet of sperm in a jelly capsule called a spermatophore on the ground or pond bottom that the female must pick up with her cloaca. This procedure involves a great deal of coordination – both parties must be ready and willing for successful mating to take place. As a consequence, elaborate mating rituals have evolved that enable salamanders of the same species to recognize and prepare each other, and then position themselves for successful sperm transfer. The mating displays of salamanders are complex and fascinating to watch. The rituals can involve clasping (amplexus), nudging, rubbing, chasing or other forms of stimulation and display. Males of some species have special glands on the chin or elsewhere that produce secretions used in the courtship. Male newts develop black nuptial pads on the feet and legs and high tail fins used in displays. In many terrestrial plethodontid salamanders, the male leads the female in a tail-straddling walk, in which the female rests her chin on the male's back and walks astride his tail.

The eggs of salamanders do not have hard protective shells or fluid-holding internal membranes. Like all amphibian eggs, they must either be laid in water or a dark, moist place to survive. Many species of salamanders, including the Coastal Giant Salamander and the four species of plethodontid salamanders in British Columbia, stay with their eggs as they develop.

Almost all species of salamanders have some sort of larval stage before transforming into adults. Salamander larvae do not differ as



Tiger Salamander larva.

much from the adult salamanders as tadpoles do from adult frogs. Like their parents, salamander larvae are carnivorous. Salamanders that breed in ponds, like newts or species of *Ambystoma*, have larvae with large, feathery external gills and high tail fins extending well up the back. The adaptations of such pond-type larvae are useful in the still waters where they live: large gills help breathing where the amount of oxygen dissolved in the water is low, and a large tail fin can aid in swimming. Most pond-type larvae are born with long balancers that stick out behind the head, but they eventually lose them. Stream-type larvae, such as those of the Coastal Giant Salamander, have much smaller gills, as large gills are not needed in oxygen-rich streams; and they have low tail fins to reduce resistance to the flow of water. The Western Red-backed Salamander and other fully terrestrial plethodontid salamanders have eliminated the larval stage entirely from their life cycle.

In some species of salamanders, an individual can retain its larval appearance for its entire life and reach sexual maturity while still in larval form. This condition is called neoteny, a form of paedogenesis, the retention of larval characteristics into adulthood. Neotenic individuals do not metamorphose, but reach the same size and live just as long as transformed salamanders. In British Columbia, the Northwestern Salamander, Tiger Salamander and Coastal Giant Salamander frequently have neotenic individuals.

Frogs and Toads

Vocalizations play important roles in the lives of almost all frogs and toads. Only a few species, like the tailed frogs, lack a voice. Frogs and toads produce many types of calls: mating calls, territorial calls, warning calls, fright calls (screams) and rain songs. Not all species have the entire repertoire – but some use the same call for two purposes. In almost every species of frog, only the males can produce calls; few females have voices.

In the spring, the voices of frogs can fill the night air. Some species breed explosively, congregating in small areas for short periods of time; male Great Basin Spadefoot Toads will set up a raucous din at their breeding site. Most species of toads in the genus *Bufo* broadcast calls from their breeding ponds, but the Western Toad does not have such a mating call. Instead, the males have a well-developed warning or sex-recognition chirp. When male toads are in breeding spirit, they can be aggressive and attempt to grab just about anything that looks remotely like a female, including other males. To recognize who's who, the males of most species have a distinctive call or chirp to identify their sex. This call is often accompanied by vigorous body vibrations. So, when a male toad grabs another male toad, he gets an argument that makes him realize his mistake, whereas a gravid female will usually not protest.

Hylid frogs, such as the Boreal Chorus Frog and the Pacific Treefrog, have a different mating system from toads. Their mating calls serve as advertisements directed at females, as well as territorial calls, directed at other males. Unlike toads, male treefrogs tend to sit in one place to call and use the calls of their neighbours to space themselves apart. The females home in on these calls to find their mates.

In many ranid frogs, males set up territories in their breeding ponds that they actively defend with calls and threatening displays, or by wrestling with intruders. Male Green Frogs and Bullfrogs threaten rivals by showing their bright yellow throat. These are aquatic frogs with extended breeding periods. The females share the pond with the males for most of the year, so there is not much need for an assembly call. Any female within a male's calling territory is fair game for that male. Green Frogs increase the intensity and frequency of their territorial call if a rival male is calling nearby. Male Northern Leopard Frogs will emit a variety of strange noises if they sense another male in their territory.

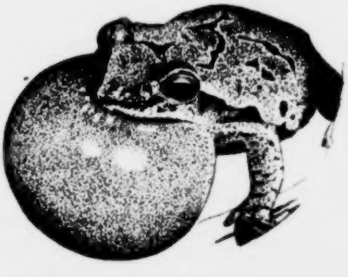
Each species of frog has its own distinctive assembly and territorial calls or songs. The songs, therefore, are good ways to identify species. In some cases, such as the two almost identical treefrogs in eastern North America – the Grey Treefrog (Hyla versicolor) and Cope's Grey Treefrog (H. chrysoscelis) – species can only be distinguished in the wild by their mating calls.

Male frogs produce their songs by passing air rapidly back and forth over the vocal chords between the mouth and lungs. The frog keeps its mouth and nostrils closed while calling, which enables him to sing under water, as does the male Red-legged Frog. Most species of frogs have expandable vocal sacs that increase the volume of sound; they can have one median or two lateral sacs, internal or external, depending on the species. The effect of a vocal sac on the sound is similar to the effect achieved by the hollow body of an acoustic stringed instrument like a guitar. By itself, a plucked guitar string is quiet, but with the resonating air inside the guitar body, the sound is greatly amplified and radiated outwards. A chorus of 25-mm-long Pacific Treefrogs can be heard more than a kilometre away because of the amplifying qualities of each frog's vocal sac. Bullfrogs, Green Frogs and other related species amplify their calls in another way. Most males of these species have much larger tympanums than females do, but we have only recently discovered why: the enlarged tympanum not only receives but also transmits sound. When the frog calls, its large tympanums vibrate in sympathy to amplify and radiate the sound.

Frogs calling in a chorus do not sound off randomly, but take turns. Some species, like Pacific Treefrogs, form impromptu duets. Each male frog spaces its call between those of its neighbour, allowing a female to pinpoint the location of a healthy mate. But these frogs risk allowing a predator to home in on their call as well. In eastern North America, Spring Peepers (*Pseudacris crucifer)* form calling trios, but Bullfrogs answer each other in a raucous chorus.

Frequently in midsummer or fall, a treefrog can be heard singing some distance from water or from up in a tree. This call is known as a "rain song" and is usually associated with a rise in humidity. Chorus frogs will often call after rains later in the summer. A song may also have some territorial significance. Sometimes a frog can be induced to sing by a loud noise nearby.

Many ranid frogs emit alarm or fright calls. Bullfrogs and Green Frogs scream and wail when frightened, as they leap into the water, or if they are captured. Many ranid frogs scream or wail as they are being eaten by a snake, especially if



A Spring Peeper peeping.

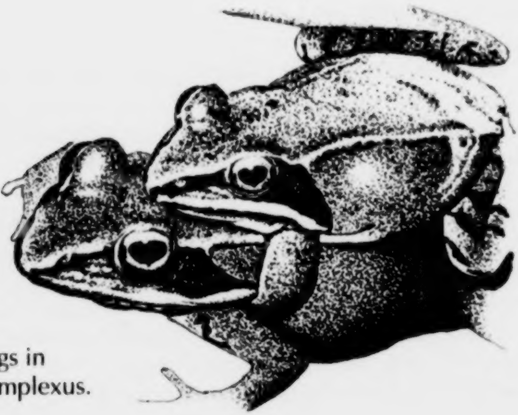
the snake catches it feet first. This is one of the few kinds of calls not restricted to males; females and juveniles can also scream, wail or sound an alarm.

Most frogs remain solitary for much of the year, although some aquatic frogs maintain territories through most of their active season. No species of frog or toad in British Columbia exhibits parental care, although many tropical frogs have territorial systems and care for their eggs or tadpoles. The tadpoles of the Western Toad show a sort of social interaction by forming schools, which consist mainly of siblings. Once they transform into toadlets they sometimes swarm overland in dense groups but soon go their separate ways.

Whatever social structure they have, all the frogs and toads of British Columbia employ a familiar breeding method. When mating, the male clasps the female with his forearms. This clasping, called amplexus, can be behind the female's arms (pectoral or axillary amplexus), or around her waist (pelvic or inguinal amplexus). Most species in British Columbia engage in pectoral amplexus, but both tailed frogs and the Great Basin Spadefoot Toad use pelvic amplexus.

All but one of the frogs and toads in British Columbia lay eggs in standing water and fertilize them externally as they are laid. Only the tailed frogs employ internal fertilization and attach their eggs to the undersides of rocks in flowing streams.

Frogs and toads in other parts of the world, especially in tropical regions, show a great variety of brooding and parenting strategies.



Wood Frogs in
pectoral amplexus.

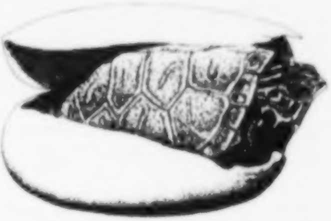
The Gladiator Treefrog (*Hyla boans*) of South America builds a mud nest; *Phyllomedusa* treefrogs lay their eggs in rolled up leaves, and many leptodactylid frogs build nests of foam. The male Mallorcan Midwife Toad (*Alytes muletensis*) of Europe carries its eggs wrapped around its loins. The female Surinam Toad (*Pipa pipa*) incubates her eggs in folds of skin on her back. Darwin's Frog (*Rhinoderma darwini*) of Chile broods its eggs in its vocal sacs. But strangest of all, the Australian *Rheobatrachus*, now believed to be extinct, brooded its eggs and tadpoles in its stomach. While our Western Toad can lay many thousands of eggs in a single breeding season, some frogs, like the many species *of Eleutherodactylus* from Central and South America and the West Indies, lay fewer than a dozen eggs in a clutch that develop directly into tiny frogs. There are even some frogs of the genus *Nectophryoides* in west Africa that give birth to fully metamorphosed young.

Turtles

As in other reptiles, turtles fertilize their eggs internally. The male has a single copulatory organ (penis) in the base of his tail. Depending on the species, courtship can be almost non-existent or fairly elaborate. During courtship behaviour in Painted Turtles and Pond Sliders (*Trachemys scripta*), the male faces the female and strokes and caresses her head with his long front claws. Copulation lasts a long time in some species; e.g., the Green Turtle takes up to six hours. In most species, the male remains on top of the female by hooking his hind legs under her shell in various ways, depending on the species; but a male sea turtle attaches himself to the female shell by his front legs.

Turtles exhibit sexual dimorphism to varying degrees in different species. In most, the male has a longer tail to house the penis and the cloacal opening occurs nearer the tip of the tail. The male often has a more concave plastron than the female to facilitate mounting the dome of her shell when mating. The sexes can be of different sizes, have different sized heads, or be slightly different in colour. In some species, such as the native Painted Turtle and the introduced Red-eared Slider (*T. s. elegans*), males have much longer foreclaws than females.

The females of many species can store sperm from a single mating for up to four years, producing clutches each year, albeit with a steadily decreasing proportion of fertile eggs. Clutch size varies



Turtle hatchling.

greatly from species to species, but can be very large (up to about 200 for the Green Turtle). Many species regularly lay two or more clutches of eggs in a breeding season, at least in the warmer parts of their ranges. In most species, the female lays her eggs in a nest, a flask-shaped hole that she digs in sand or rotting wood using her hind feet. After laying her eggs, she usually fills in the hole and tries to conceal the nest from predators by spreading soil around or repeatedly passing over it. This is the only time that adult sea turtles (only the females) venture onto land, as their modified structure makes them very clumsy and vulnerable out of the water. Various predators take a heavy toll on turtle eggs. In temperate areas, hatchlings of some species usually overwinter in the nest.

Lizards

Most lizard species are sexually dimorphic in colour and pattern, body size and other features. Even in species with no fixed colour differences between sexes, patches of bright colour can develop in various regions of the body of the male or female during the breeding period, as in male Western Skinks. One interesting sexual dimorphism is the degree of development of the femoral pores, usually a single row on the underside of each hind leg and usually better developed in males. Each pore has a gland that secretes a waxy substance. These glands are particularly active in the breeding season, producing a series of finger-like projections on the underside of each hind leg, possibly to stimulate the female during courtship behaviour. The Pigmy Short-horned Lizard has femoral pores, but the Northern Alligator Lizard and Western Skink do not.

Lizards defend their territories vigorously, especially when breeding or feeding. Territorial behaviour is mainly demonstrated by males, but is also shown by females in some species. In view of the general importance of vision in species and sex recognition in lizards, it is not surprising that territorial defence usually consists of visual displays. Such displays include exposing brightly coloured patches on the body or a brightly coloured gular fold on the throat, and various sorts of bobbing behaviours. The geckos, however, which are mainly nocturnal, may use auditory signals to indicate territory; many species of geckos are capable of making calls and are apparently the only lizards with pronounced vocal abilities. Courtship behaviour in lizards is variable, although a general statement might be that nocturnal lizards tend to rely on tactile stimulation while diurnal lizards use visual cues. In most species, courtship ends with the male biting the female on the back of the neck, followed by copulation.

Oviparous (egg-laying) lizards may use natural cavities to deposit their eggs, but many dig their own nests. Most species dig with their forelegs and refill the hole with their snout and front legs, but others dig with the hind legs. While maternal care of the young is not shown by most species, some care for their eggs during incubation, aid the young in hatching or take limited care of the young after hatching. A female Western Skink will guard the eggs in her nest and even the young hatchlings until they disperse from the nest. The number of eggs or young per clutch varies depending on species, body size of the mother and other factors; most species produce two to six, but some can lay up to sixty eggs. Although most lizards lay eggs, two of the four native species in British Columbia give birth to live young.

Snakes

The odour of the female snake is important in attracting males, and mating involves a great deal of physical contact between the sexes. Typically, the male lines up alongside the female with his body on top of hers at several points; he rubs his body, especially his head, up and down her body. In some snakes, such as the Gopher Snake, the male bites the female behind the head during mating.

Each male has two copulatory organs, called hemipenes, but uses only one at a time. In some species, such as the Common Garter Snake, courtship behaviour involving many males and a single female is common, although only one male is usually successful in mating with the female. Immediate copulation with more than one male is probably prevented by a copulatory plug that forms in the female's cloaca shortly after mating, but females in some species continue mating with other males after the first. Males can mate more than once during any given breeding season. In temperate latitudes, mating usually takes place in spring (sometimes in fall) and often immediately after emergence from hibernation. As a result, mating activity in many species, especially those that hibernate in large groups, is frequently confined to the area of the hibernaculum or overwintering site, which may be a considerable distance from the summer habitat. Courtship and mating of snakes in the hibernaculum is easy to observe in such large groups. Rattlesnakes, by contrast, mate in late summer away from the overwintering site.

Although some species of snakes bear live young, most lay eggs. Egg-laying snakes usually deposit their eggs in soft materials, such as rotting logs or humus, or in damp cavities in soil, although some species, most notably certain cobras, can build nests out of debris. In at least one cobra species, both sexes participate in nest building. Some species of snakes (e.g., pythons) brood their eggs, but show poorly developed parental care. In British Columbia, we have five species of live-bearing snakes and four egg-layers. None shows any parental care of their offspring.

Development

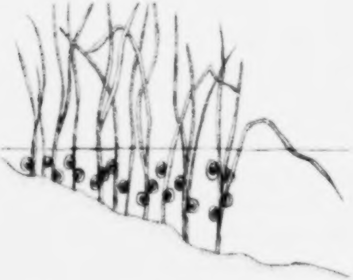
Amphibians and reptiles differ greatly in how they develop. Indeed, this is one of the major distinguishing characteristics of the two groups. Amphibians have relatively simple eggs, with the embryo in its capsule surrounded only by a thick coating of jelly. Reptile eggs are more complex. There is no jelly layer, but the embryo is surrounded and sustained by three extra-embryonic membranes: the amnion, allantois and chorion, which it grows early in development. The amnion forms a fluid-filled sac that surrounds the embryo, the allantois forms a sac for isolating waste products, and the chorion, the outermost membrane, protects the whole egg and allows gas exchange for the embryo. The allantois is also important in gas exchange, especially later in development when it completely lines the inside of the chorion. Blood vessels in the allantois move respiratory gases between the embryo and the outer part of the egg. A hard or leathery shell surrounds reptile eggs. The presence of an amnion distinguishes a reptile's egg as amniotic – thus, reptiles are known as amniotes, as are birds and mammals. In contrast, amphibians, without the extra-embryonic membranes in the egg, are called anamniotes.

Amphibians

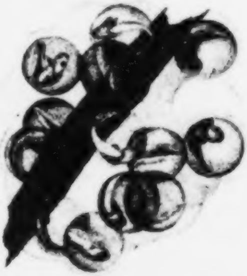
Like all amphibian eggs, frogs' eggs are surrounded by transparent jelly. This makes the development of the egg inside easy to watch as it proceeds from a single cell to a tadpole ready to hatch. The newly emerged tadpole is helpless. Initially, it has non-functional eyes, no legs and a closed-off mouth. It has external gills and an incomplete tail. All the newly hatched tadpole can do is stick to its egg mass with suckers located under its head. Shortly, though, its eyes, mouth and tail develop and it can swim away. A flap of skin on each side of the head grows back over the gills to cover them. Thereafter the water that flows over the gills is taken in through the mouth and expelled through a spiracle usually located on the left side of the body.

Legs develop as the tadpole grows. The front legs develop first but their growth is hidden by the skin that covers the gills. Consequently, the developing hind legs are the first to be noticeable. When the tadpole transforms into a little frog, the front legs pop out from under their flaps of skin, with the left leg emerging through the spiracle.

One of the characteristics of amphibians is their two-part life history; most species pass through a free-living larval stage before transforming into adult form. This kind of life history is not uncommon throughout the various branches of the animal kingdom, but among the terrestrial vertebrates it occurs only in the amphibians. The larvae of most amphibians look and behave quite differently from the adults, and engage primarily in eating and growing. They may live in a different habitat or eat different foods



Rough-skinned Newt eggs.



Northwestern Salamander eggs.

from the adults, which also reduces competition between life stages, an advantage if resources are limited. A frog's larva is a tadpole, just as the butterfly's larva is a caterpillar and the beetle's is a grub. The process of transformation from the larval to the adult form is called metamorphosis.

In amphibians, metamorphosis is mediated by hormones, especially thyroxine, which is produced in the thyroid gland located near the throat. Tadpoles or salamander larvae that have had their thyroid surgically removed will not metamorphose unless they are given thyroxine. Iodine is a vital ingredient in thyroxine production, though only a trace amount is needed. If the water in which the larval amphibian swims has absolutely no iodine, then the larva will not be able to produce thyroxine and will not transform. The transformation of a tadpole to a frog is a spectacular change. The animal undergoes severe external changes: it loses its tail, grows legs, its eyes bulge, and the colour and texture of the skin changes. It also experiences great internal changes: it resorbs its gills and grows lungs; the intestine shortens and differentiates to accommodate a carnivorous diet; blood vessels alter their courses. All metamorphic changes are governed by the various tissues' reaction to thyroxine. Salamander larvae do not go through quite as marked a metamorphosis as tadpoles, but they also change in appearance, behaviour and physiology as they transform into terrestrial adults.

The release of thyroxine from the thyroid gland is controlled, in turn, by the release of a thyroid stimulating hormone, produced by the pituitary gland under the brain. The release of this hormone is controlled by another secretion that is produced by the hypothalamus of the lower brain, whose release in the tadpole, is stimulated by thyroxine. Thus, in a roundabout way, release of thyroxine stimulates the release of more thyroxine, a positive feedback loop driving metamorphosis to completion.

Not all amphibians undergo metamorphosis. Some salamander species basically remain as permanent larvae. It is thought that in some of these species, the hypothalamus may not produce enough of its secretions.

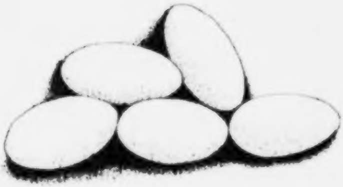
Coastal Tailed Frog going through metamorphosis.
Brent Matsuda.

These species, like the Mexican Axolotl (*Ambystoma mexicanum*) or the neotenic forms of the Northwestern Salamander and Tiger Salamander, can be made to transform if they are given thyroxine. Other species of neotenic salamanders may simply be insensitive to the actions of thyroxine. Members of the families Proteidae and Sirenidae will not transform even when given thyroxine.

Many other salamanders, including our plethodontid salamanders such as the Ensatina, Western Red-backed Salamander and Coeur d'Alène Salamander, and many tropical frogs bypass the free-living larval stage by going through direct development to the adult form in the egg. The young of these species hatch as tiny replicas of their parents. Many species of amphibians show parental care, especially these direct-developing species, which lay their eggs in moist places on land. Because the eggs have no shell to prevent them from drying up, the parents keep them moist with their own bodies, and eat dead or diseased eggs so the rest stay healthy. If a tending adult is removed from a clutch of terrestrial amphibian eggs, the eggs have a much reduced chance of survival.

Reptiles

The major feature that allows reptiles, birds and mammals to be completely terrestrial is the amniotic egg, although this characteristic is not so apparent in mammals because most are live-bearing. The important point about the amniotic egg is that the developing embryo is bathed in fluid that is completely enclosed by a membrane called the amnion. The egg is enclosed in a shell that protects it from mechanical damage and, to some extent, from desiccation. In birds, the incubating parent controls water loss from the eggs by regulating the relative humidity in the nest. Most reptiles employ a simpler but more limiting method – they find moist places to lay their eggs. Moist microhabitats occur in most places at some time or other. Because the larger, shelled reptile eggs are much more resistant to desiccation than amphibian eggs, it is not surprising that many reptiles can live in arid terrestrial environments. But unlike amphibian eggs, reptile eggs cannot



Reptile eggs.

develop in water, so marine species are obliged to return to land to lay their eggs. Most of the tropical sea snakes get around this requirement by bearing live young.

Live-bearing (viviparous) reptiles completely avoid the problem of where to deposit their eggs. In British Columbia, two of our three native lizards and five of our nine snakes bear live young. Females in these species do not lay shelled eggs, but retain the developing embryos in membranous envelopes within the body, giving birth to fully-formed young. The three most northerly distributed reptiles in British Columbia are all live-bearing snakes: the Rubber Boa, Common Garter Snake and Western Garter Snake. In general, viviparity in lizards and snakes in cool climates is believed to be advantageous because the female, by thermoregulating, can provide more nearly the optimum temperature for embryonic development of the young. There is evidence that gravid females of some viviparous species maintain a slightly different, less variable body temperature than do males and non-gravid females. Eggs laid and untended by oviparous (egg-laying) species are at the mercy of the environment. Since the development rate of reptile embryos is related to temperature, the incubation time of eggs of oviparous species can be very long in a cool summer. This is a great disadvantage in areas where summers are short. All turtles are oviparous, which may limit their northern distribution.

Of course, viviparity also has disadvantages. Female snakes that spend several months carrying young do not feed very often and, consequently, show reduced growth (reptiles generally grow throughout their lives, albeit more slowly as they age). For most reptiles, litter size is related to female body size, so a litter size may be smaller if the female's growth was inhibited by a previous reproductive effort. And in places where the growing season is very short (e.g., northern latitudes), females may give birth late in the summer and not have time to eat enough to obtain sufficient nutrients for reproduction the following year. Female rattlesnakes in British Columbia never produce offspring in consecutive years and can have reproductive cycles exceeding two years. This phenomenon has not been demonstrated in our live-bearing lizards, which are apparently able to reproduce in successive summers. The short growing season of northern areas generally restricts reptiles to the production of only one brood per year.

Turtles live long provided they can get through the early stages of life when they are small and vulnerable. Many species can live up to 50 years; box turtles *(Terrapene)* probably exceed 80 years in maximum lifespan. Reports of older turtles are difficult to verify, but some may be true, especially those applying to large species such as giant tortoises. Contrary to popular opinion, turtles grow rapidly under natural conditions, and many species, including some sea turtles, are sexually mature by the age of three years. Most species reach maturity in the first ten years of life. In contrast, the Desert Tortoise *(Gopherus agassizii)* of the southwestern United States takes 15 to 20 years to mature.

Temperature Relations

Amphibians and reptiles are popularly – yet somewhat misleadingly – referred to as cold-blooded. Normally, amphibians and reptiles are unable to raise their own internal body temperature through their own metabolism. This makes them ectotherms – animals dependent upon their surroundings to provide them with warmth. They are also unable to maintain a constant body temperature by their own metabolic regulation, which makes them poikilotherms – animals whose temperature varies with the temperature of their surroundings. Amphibians and reptiles are not necessarily cold; if their surroundings are hot, so are they. In most but not all cases, ectothermy and poikilothermy go together, as in most amphibians and reptiles, and this is what is usually meant by the term "cold-blooded".

By contrast, mammals and birds generate their own body heat (endothermy) and tend to keep it constant (homeothermy). Being endothermic may seem to be a great advantage, as it enables higher rates of activity no matter what the weather or temperature. But endothermy comes at a high price. Endotherms need fuel to maintain their body heat – they must be able to find plenty of food or eat constantly to remain active. They must also insulate their body against the cold with hair, fat or feathers, and have cooling devices, like sweat glands, when they are too hot. There are just two known types of significant endothermy in reptiles: when brooding eggs, some female pythons shiver to produce heat, and there is evidence that the Leatherback Sea Turtle produces internal heat by muscular activity. Otherwise, rather than metabolically fight against the climate and struggle to maintain internal temperatures, ectothermic amphibians and reptiles conform to it more closely, and that affects everything they do.

Amphibians and reptiles, by virtue of their ectothermy, do not eat food to produce body heat; instead, they feed opportunistically and use the energy for growth and reproduction. This makes them capable of rapid growth and prolific reproduction under the right conditions. A toad can quadruple in size in a few months. An adult's mass may be a thousand times what it was as a larva. Garter snakes (*Thamnophis*) can have litters of 30 or more babies, which is impossible for mammals.

Amphibians and reptiles also can be much smaller than the smallest mammals or birds. Endotherms cannot be too small, for they would lose heat too rapidly. The smallest endotherms – shrews and hummingbirds – must constantly eat high-energy foods to live their short, frantic lives. But there are tropical frogs no more than a centimetre in length as adults. Hatchling snakes, lizards and salamanders can be minuscule. Even some species of amphibians and reptiles in British Columbia start their lives tiny. But activity for an amphibian or a reptile is restricted to conditions with favourable temperatures, which means it must avoid extreme heat or cold. Consequently, amphibians or reptiles living in regions with cold winters or hot summers must lie dormant during those times, either hibernating or aestivating, until more suitable conditions prevail.

Instead of using physiological thermoregulation, ectothermic amphibians and reptiles keep their body temperatures at a fairly constant level through their behaviour. Behavioural thermoregulation is especially well illustrated by lizards as they shuttle back and forth between sunny perches and shady retreats, hide in cool shelters during the heat of the day, change posture to alter their contact with warm ground or adjust their orientation to the sun. Under extreme heat stress they may pant. Panting lowers body temperature by evaporative cooling, as sweating does for humans. Of course, amphibians and reptiles can thermoregulate behaviourally only over a relatively narrow range of ambient conditions and cannot tolerate very cold or very hot surroundings, especially extreme heat. Frigid temperatures will kill reptiles, but most species can tolerate a drop in body temperature to a few degrees below freezing. Some can survive cold as low as -8°C. The correlation between body and environmental temperatures is far from perfect in some environments and some animals achieve a remarkable independence from environmental temperatures. Many reptiles bask in sunlight to raise their body temperature considerably above environmental temperatures. For example, a species of *Liolaemus* lizard that lives at about 3900 metres elevation in the Andes of South America can maintain a body temperature of 31°C at air temperatures of 0°C, mainly by absorbing solar radiation.

As a group, lizards seem to inhabit much hotter environments than do other reptiles. They can tolerate higher body temperatures and are the dominant vertebrates during daylight hours in hot deserts. Lizards are relatively uncommon in temperate climatic regions, including British Columbia. It is not true, however, that lizards are active under the very hottest conditions or that they remain exposed under the hot sun for prolonged periods. The ability to change colour is important in the temperature regulation of large lizards, as their body temperatures are significantly related to incoming radiant energy. But small lizards rely more on the ambient temperature and convection, so changing colour is not as important. Behavioural thermoregulation is well-developed in desert lizards. During the cooler part of the year they are active around the middle part of the day, but in mid summer they may be active only in the early morning and late afternoon, remaining under cover at midday. Not surprisingly, desert lizards have proven to be attractive subjects for the study of temperature relationships.

Because the metabolic activity of an amphibian or reptile varies with temperature, the animal is much more active when it is warm than when it is cold. When a poikilothermic animal's body temperature is just above freezing, its metabolic activities slow to a minimum. The oxygen demand of a frog lying dormant under water at a few degrees above freezing is so low that it obtains enough to live on entirely through its skin – yet this same animal can drown in summer when it's oxygen demands are much greater. When the water temperature rises in the spring, the metabolic activity of the hibernating amphibian will also rise and it will again become active. During some mild winters on the south coast of British Columbia, inconsistent temperatures allow some species of amphibians to be periodically active.

Winter Survival

Northern amphibians and reptiles all must hibernate during the winter when temperatures drop too low for active behaviour. Although the metabolic rate of a hibernating animal is much lower when it is active, it does rely on a limited supply of energy reserves stored as fat and glycogen. Since northern winters can be long, any adaptation that allows food reserves to be conserved is advantageous. Several species of northern reptiles reduce energy expenditures during hibernation by depressing their metabolic rate below that which it would be at the same temperatures in the summer. This appears to be an acclimation response to low temperatures, but opposite to the acclimation response when active.

Snakes in northern areas often pass the winter at communal hibernating sites or dens. Dens may be used by hundreds or even thousands of animals at a time, and used year after year by the same individuals. Communal hibernating sites of snakes are usually in rocky outcrops or talus slopes where rock crevices allow the animals to go underground below the frost line. In British Columbia, the most spectacular examples of communal hibernation are rattlesnakes that den in large numbers, sometimes with other species of snakes. Large groups of garter snakes also hibernate in dens in northern British Columbia.

The reason for communal denning is unknown. In some cases, it may simply reflect a shortage of suitable hibernating sites in the immediate area. But reptiles that hibernate at communal dens also derive some benefits in terms of reproductive success. Most temperate-zone reptiles mate in spring shortly after emergence from hibernation. Communal hibernators often mate inside the den, and therefore do not waste as much time and energy finding mates, allowing them to concentrate on other activities, such as feeding. This strategy is important in northern regions where the growing season is short. But the Western Rattlesnake mates in late sumer away from the den, even though it hibernates communally. It is doubtful that communal hibernation offers any advantages in terms of heat retention, especially since the hibernating animals are not necessarily in contact with one another, nor generate enough body heat to make contact worthwhile for this purpose.

Almost all amphibians and reptiles in northern latitudes survive the winter in places where they will not freeze. Columbia Spotted

Frogs and adult Painted Turtles hibernate under water, well beneath the surface ice. The frogs, like all amphibians, can gain enough oxygen through their skins to be able to respire all winter at low temperatures without needing to breathe air. Painted Turtles effectively hold their breath all winter, although they can gain a small amount of oxygen from the water across their skin, particularly the skin lining the mouth and throat. They are so cold that their metabolism drops to minimum life-sustaining levels and they mainly respire anaerobically (without oxygen) using up their stored supplies of glucose and producing lactic acid in their tissues and blood. Turtles metabolize calcium carbonate into their blood from their bones, including the shell bones, as a buffer against excess acidity, but blood acid can still reach a level that would be lethal to a human. Come spring, a turtle emerging from hibernation swims immediately to the water's surface for a gasp of air, deeply breathing in sorely needed oxygen. Although they typically hibernate on land, some snakes, including Common Garter Snakes, can survive periods of submergence in water during hibernation.

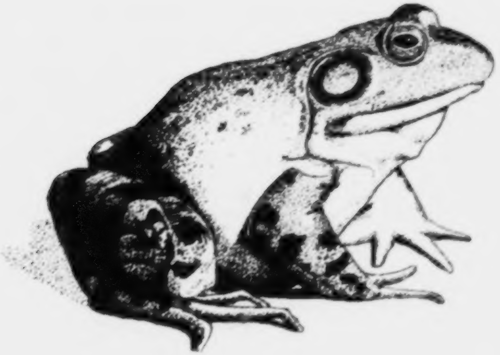
Animals that hibernate on land, including toads, snakes, lizards and plethodontid salamanders, seek refuge in hibernacula deep below ground to avoid frost, or bury themselves below the frost-line. Their winter metabolism may be low, but usually not so low that they cannot dig down to escape penetrating frost. For most animals, freezing is deadly, but a few species of amphibians and reptiles can tolerate freezing. Freeze-tolerance has been most intensively studied in Wood Frogs, which hibernate under the leaf litter of the forest. Wood Frogs are not particularly good burrowers, but they do not need to retreat from all frost because they can tolerate freezing of a substantial portion of their body water and still survive. When a Wood Frog begins to freeze, it infuses its blood with glucose derived from a large store of glycogen in its liver. The glucose acts as an anti-freeze to keep tissues from freezing right away and as a cryoprotectant that limits the size of ice crystals forming in the blood and tissues. When tissue freezes, the cells may die, not because they are frozen inside, but because ice crystals in the surrounding fluid cause mechanical damage and remove free water from inside the cell. The glucose prevents ice crystals from growing too large and balances the onset of freezing inside and outside of the cell. A Wood Frog can appear to be almost entirely frozen solid, yet thaw out and survive.

In the north, where winters are long and cold and the summer growing season is short, amphibians and reptiles show various physiological adaptations to coping with cold. In addition to reproductive adaptations, such as live birth among the reptiles, northern species are better able to move and perform other functions at low temperatures than species in warmer climates. Many species in northern regions also show a marked ability to acclimate to changing conditions, most notably amphibian species. A brief exposure of even a few days to cool conditions will allow them to function normally at lower temperatures than situations where conditions change suddenly. This is particularly advantageous in the autumn as the weather becomes progressively cooler. The reverse process, acclimation to higher temperatures, occurs in the spring.

Economic Importance

All salamanders and their larvae are strictly carnivorous throughout their life. The tadpoles of frogs and toads are mainly herbivorous and consume aquatic plants, but after they transform into adults they eat animals. Aside from some notable cases of herbivory among tortoises and iguanas, most reptiles are carnivorous, including all our native species in British Columbia. Amphibians and reptiles thus play an important role in the energy flow of ecosystems as predators. Amphibians generally consume small animals such as insects, worms or other invertebrates. In turn, they serve as a food source for larger predators – e.g., snakes, Raccoons (*Procyon lotor*), birds and fishes – thereby transferring energy up the food chain from invertebrates that would otherwise be too small and energetically inefficient for larger predators to forage on directly. Frogs and toads consume large numbers of insects, helping to destroy many agricultural pests. Rarely can an amphibian eat an animal large enough to be considered economically important, although Bullfrogs may be an exception. Rattlesnakes and Gopher Snakes eat rodents that are considered pests. No amphibians in British Columbia are directly harmful to humans, and the Western Rattlesnake is the only dangerous reptile.

Many amphibians and reptiles, especially large frogs, salamanders and turtles, are used in biological research and in teaching. They have been considered ideal subjects for many research projects because they can be readily collected in many areas and they are fairly easy to maintain in a laboratory. Medical research, embry-



The non-native Bullfrog eats just about anything it can fit into its mouth.

ology, genetics, physiology and other scientific fields rely heavily on amphibians, especially frogs. Some species, such as the Northern Leopard Frog, have been collected for research and teaching purposes and are overexploited in some parts of North America. Fortunately, technological advances now provide a "digital" frog for biology anatomy classes.

Large frogs, including Bullfrogs, are sometimes served in restaurants, although many commercial frogs' legs are now imported from Mexico or Southeast Asia. Most of the introductions of Bullfrogs in western North America, which is outside the Bullfrog's original range in eastern North America, were due to attempts to grow Bullfrogs commercially. These universally unsuccessful, now defunct frog farms were established when the eating of frogs' legs was more in vogue. The feral offspring of released farm inmates have established healthy, growing populations in many localities in British Columbia and elsewhere in western North America. These introduced frogs have created considerable conservation problems due to their voracious appetite and large size; they feed on native fauna, including birds, fishes, other frogs and anything else they can fit into their cavernous mouths. Bullfrogs are still exploited for food in their native range. In contrast to their growing numbers in the west, native Bullfrog populations in eastern North America appear to be declining in many areas.

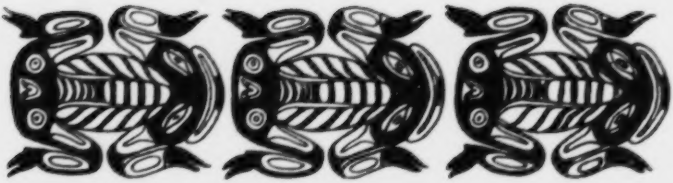
Reptiles are more often large enough to be economically consequential. The economic importance of turtles is and has been mainly as a source of food for humans. Most species are edible, although many are not large enough to be worthwhile. Larger turtles, such as the Snapping Turtle (*Chelydra serpentina*) and sea turtles, are harvested for food. In some parts of the world, especially Asia, many turtle species are threatened by uncontrolled hunting. Overharvesting turtles and their eggs has put a strain on many turtle populations, necessitating various conservation measures. Turtles do not have any direct economic value in British Columbia, although the Painted Turtle probably plays an important role as a scavenger in lakes and ponds. Rattlesnakes are raised to be eaten in parts of the United States, but not in British Columbia. Alligators are commercially farmed for their meat and leather. In some parts of the world, such as Asia, large snakes and lizards are harvested for their skins.

Countless numbers of children have been introduced to the wonders of natural history and the living world through a pet turtle or a metamorphosing tadpole in a classroom. Amphibians and reptiles may not be as playful as a dog or cat, but some species are every bit as spectacular as tropical birds or fishes. Every year large numbers of exotic amphibians and reptiles are imported for the pet trade. This can sometimes have serious consequences for wild populations if they are over-collected, but reputable reptile and amphibian dealers buy their stock from breeders.

Amphibians and Reptiles in Folklore

In many European cultures, amphibians and reptiles have often been associated with spirits of evil. The "eye of newt" as an ingredient to witches' brew, and the serpent as the embodiment of evil in the Garden of Eden come to mind. Throughout most of the rest of the world, amphibians, particularly frogs, are regarded as harbingers of spring and good times. Around the world, frog songs herald the good weather of spring. In Panama and Costa Rica, the Golden Frog, a colour form of *Atelopus varius,* was formerly a religious symbol and is still revered as a popular artistic motif. In Mexico, one legend has frogs being responsible for the coming of the life-giving rains, relating how they tricked the gods of the winds into bringing rain. A European legend tells the story of a toad with a magical stone in its head, and how the toad could be tricked into relinquishing its toad-stone. Shakespeare alludes to the toad-stone in *As You Like It*:

"... the toad, ugly and venomous
Wears yet a precious jewel in his head."



Frog motif by Haida artist Charles Edenshaw.

The "jewel" may refer to the gleaming gem-like eyes of the toad, the probable origin of the toad-stone legend. In China, a three-legged toad with a coin in its mouth is a mythical embodiment of both greed and thrift.

In British Columbian aboriginal cultures, frogs and toads are frequent motifs in symbolic artwork and crests. They are especially prominent as crests among the Tsimshian speakers of the Skeena River region and the Haida of Haida Gwaii (the Queen Charlotte Islands). Haida legends hold that frogs are the source of wisdom and knowledge and that two frogs guard the entrance to the realm of the Thunderbird, ready to sound a warning of any intruders. These legends may actually refer to the Western Toad, the only native amphibian found on Haida Gwaii. Male toads vigorously and noisily chirp warning calls when picked up or handled. And legend recounts that the frogs long ago fled the Haida's island homeland after the Frog Chief encountered Black Bear, who stepped on him and frightened him for fun. But the Haida were also travellers to the mainland and frequently portrayed animals in their artwork that they may have encountered elsewhere. It is possible that the frogs they depicted represented Columbia Spotted Frogs or Pacific Treefrogs, which they may have observed on these excursions. Alternatively, they may have acquired through marriage some of the artistic motifs of mainland groups, such as the Tsimshian.

A "man in the moon" story originates from the Stl'atl'imx (Salish-speaking people of the Lillooet area). Two versions of the story feature either one frog courted by Beaver or three frogs courted by Beaver and his brothers. In the simpler version, Beaver proposes marriage to Frog but Frog refuses. The tears of the rejected Beaver are so copious that he floods the river, sweeping away Frog and her house to the land of the Moon. Kindly, Moon invites Frog to sit by his fire. But Frog wants to get closer to the fire and so

Moon finally lets her sit on his forehead. At night, so the story ends, when the moon is up and full, Frog can still be seen sitting on the brow of the moon.

Among the Nuxalk of Bella Coola, toads can come to the aid of mortal humans. If a person witnesses a toad being swallowed by a snake, he or she will be wise to kill the snake, save the toad, and say to it, "Please help me when I am in trouble." The toad will not forget this. Should that person fall into a river, the toad will grow large and come to the rescue. Snakes, though, are traditionally regarded with fear and disgust. The Nuxalk believe that snakes are the offspring of a dreadful "Mother of Snakes" – they enter the stomachs of human beings and breed uncontrollably in there with deadly results. A branch of spiny swamp gooseberry is considered to be a deterrent. Frogs were also mythic causes of skin diseases, requiring a shaman to remove the supernatural frog from the ailing person's body by thrusting a finger up the patient's nose and banging down on his head.

Turtles do not figure prominently in the stories and legends of British Columbia's First Nations, but among the various groups of Iroquois in eastern Canada, the turtle is a revered clan symbol. To the Mohawk, the turtle *Anowara* carried the seeds of their most important crops – corn, beans and squash – upon her back and scattered them over the face of the earth as she walked.

Since the time of legends, people living around Okanagan Lake have occasionally reported seeing Ogopogo, a large, allegedly reptilian creature, swimming in the lake. A similar animal, called Cadborosaurus, has been spotted in the marine waters off the coast of Vancouver Island. Sporadic sightings of these beasts continue, but evidence of their existence is lacking.

Conservation Status and Protection

Recent trends indicating global amphibian population declines have raised great concern among scientists, and British Columbia has not been exempt. It is not difficult to see how the decline of amphibians could lead to ecosystem imbalances. In some places, amphibians are the most abundant vertebrates present and their biomass alone can exceed the cumulative weight of all the other vertebrates found in the same area, even if most people hardly notice them. They are, after all, relatively small, nocturnal and reclusive. Their abundance has great impact on populations of the insects that they eat in huge quantities. Amphibians, in turn, provide an important source of food for many animals, including birds, fishes, reptiles and mammals.

Reptiles also face threats to their existence. The unfortunate, near-universal human loathing of snakes ensures that countless numbers are needlessly and unthinkingly killed each year, even though our only seriously venomous snake species is responsible for almost no deaths in British Columbia. Tropical turtles and tortoises are severely threatened from over-harvesting for food and poaching for the illegal pet trade. Green and Leatherback turtles face a multitude of inadvertent threats from fishing nets, boats and pollutants when they enter our waters.

No one cause is responsible for the declines in amphibian and reptile populations. Habitat loss due to land clearing for urban development, agriculture, logging or other reasons is a major problem for these animals. Water development projects such as dams can destroy habitat by scouring streambanks and breeding grounds, inundating habitats or causing drought during critical periods of amphibian development. Wetlands drained for agricultural purposes and irrigation, and habitat destroyed by grazing cattle also pose problems.

Amphibians are also disappearing from near-pristine areas where there is no visible disturbance. No cause has been identified to explain the demise of populations of the Northern Leopard Frog in British Columbia. Common micro-organisms such as fungi, bacteria and viruses have been found associated with die-offs in the tropics, but it is not known whether they were the direct cause of lethal disease or secondary invaders taking advantage of an already weakened animal. Chemical contamination from acid rain and contaminated snowmelt runoff, heavy metal leaching from mining operations, fertilizers, pesticides, or chemicals used in road maintenance and construction may cause hormonal imbalances that alter reproductive ability or compromise the immune system. Other factors implicated in reducing the survival and development of amphibian eggs and larvae include the increase in UV radiation resulting from depletion of the ozone layer due to chlorofluorocarbons (CFCs), and the increased levels of atmospheric carbon dioxide (i.e., global warming) resulting from deforestation and the burning of fossil fuels.

Other problems for amphibians result from introduced animals, including fishes brought from other areas to stock a lake for commercial or recreational purposes without regard to their ability to out-compete native animals, feed on them or transmit diseases. Outdoor recreational activities, themselves, have impacts upon populations. Animals and habitats get trampled underfoot, and human disturbance of streams and ponds can lead to increased siltation that can smother eggs and larvae or coat algae and other food sources. Automobile traffic means roads, and roads result in road kills and habitat fragmentation. Usually a combination of factors is at work.

Declines and extinctions occur naturally in animal populations. Some biologists argue that the noticeable declines over the last 20 years may be natural, only becoming more visible due to our increased awareness of amphibians and reptiles. Perhaps extremes in climatic conditions brought about by inconsistent weather patterns such as El Niño or La Niña may make amphibians more vulnerable to stress. We do not have records for amphibian and reptile populations as thoroughly documented and extending for so long a time as we do for bird populations. Thus it is not easy to assess whether current population declines are natural fluctuations or abnormal catastrophes. Nevertheless, we have been witnessing in recent years not just declines in populations, but losses of populations altogether. These declines are real.

Many species of amphibians and reptiles in British Columbia are declining or even in danger of extinction: 9 of the 21 amphibian species and 11 of the 18 reptiles are listed as endangered or vulnerable by the Wildlife Branch of B.C.'s Ministry of Environment. The federal Species at Risk Act designates status and protection based on the recommendations of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In British Columbia, COSEWIC lists 10 species of native amphibians and 11 species of native reptiles in its categories of Extirpated, Endangered, Threatened and Special Concern. See the Checklist (pages 65-67) for current provincial and federal status designations of British Columbian amphibians and reptiles. The Nature Conservancy of Canada lists species based on the threats it faces on a global scale. It considers the Coeur d'Alène Salamander, Oregon Spotted Frog, Green Turtle, Leatherback Sea Turtle and Western Pond Turtle to be rare or uncommon, with populations possibly vulnerable to large-scale disturbances.

Many countries, including Canada, have signed the Convention on International Trade in Endangered Species of wild fauna and flora (CITES), which restricts the commercial movement of endangered species or the products made from them throughout the world. Fortunately, none of our amphibians or reptiles are big black-market targets. As such, only Green and Leatherback turtles – both transients through our coastal waters that do not breed in British Columbia – are listed by CITES.

The status designated for a species is based on its having a certain probability of extinction or extirpation from Canada or the province in the near future. Extinction risk assessments are based on comprehensive information that is used to make predictions about the species' probable fate if current trends continue. Designations for species differ from region to region. The range of the Coastal Giant Salamander barely extends into Canada in a small area in southwestern British Columbia, so there is only a limited population in the province. This species is considered rare and vulnerable in British Columbia and Canada, yet is quite common in the northwestern United States where it is not recognized to be at risk. This does not mean that a species should not be protected in British Columbia or Canada if it is common elsewhere. The loss of a species where it once ranged is still a decline in biodiversity and can indicate other, undetected losses and habitat degradation.

British Columbia's amphibians and reptiles do have some measure of legal protection. All native amphibians and reptiles are protected under the British Columbia Wildlife Act. Permits are required to capture, possess, handle or disturb these animals in any form, including preserved specimens or their parts. Officially, this includes keeping them as pets or using them for educational purposes. Some species are indirectly protected by the British Columbia Forest Practices Code, which has established protected Wildlife Habitat Areas for species such as the Coastal Tailed Frog, Rocky Mountain Tailed Frog, Racer, Gopher Snake and Rubber Boa.

Selected References: Adams 1999, 2000; Bishop and Pettit 1992; Blaustein and Wake 1995; Blaustein et al. 1994a, 1994b, 1995; Cannings et al. 1999; deMaynadier and Hunter 1995; Environment Canada 1992; Green 1997, 2000, 2003; Houlahan et al. 2000; Ministry of Forests 1999; Pechmann and Wilbur 1994; Power et al. 1989.

Tiger Salamander and Painted Turtle habitat in the Okanagan.
BRENT MATSUDA.

Where to Find Amphibians and Reptiles

Reptiles and amphibians occur in a diversity of habitats throughout British Columbia and finding, observing or photographing them is a thrill. Do not take them home, though, as the British Columbia Wildlife Act requires permits to collect native species. Leave animals undisturbed as much as possible. Collection permits are generally given out only to legitimate educational or research institutions. Contact the Biodiversity Branch of the B.C. Ministry of Environment for details on obtaining permits. Even with a permit, a wise and prudent herpetologist never collects large numbers of a given species from one locality, especially gravid females.

Newts and ambystomatid salamanders are easiest to find on rainy nights in the breeding season when they congregate in breeding ponds. Ponds, puddles and ditches often harbour numerous larval salamanders and tadpoles soon after they hatch. Post-metamorphic salamanders tend to remain secretive most of the year. While rainy days, even in summer, can bring Rough-skinned Newts out while the sun is up, most salamanders forage above ground only at night. During the day, salamanders tend to remain hidden under logs, dead wood or the bark of dead trees in damp forests. Bear in mind that many animals rely on the microhabitats provided by logs and rotted wood. If you must turn over a log or

A creek near the Chilliwack River: habitat for the Coastal Tailed Frog and Coastal Giant Salamander. BRENT MATSUDA.

Habitat of the Racer, Western Rattlesnake and Western Skink in the south Okanagan. BRENT MATSUDA.

rock, be sure to replace it just as it was. It is best to return an anima to the same log or rock where you found it, replacing the log o rock first, then releasing the animal alongside it, allowing it to find its own cover, rather than risk squashing it by placing the log o rock over top.

The easiest way to find frogs and toads is to search for them i the spring when they are breeding. All of our frogs and toads, except the two species of tailed frogs, breed mainly in ponds, small lakes or sloughs. Good potential breeding sites can be located by scouting around during the day and then visiting later in the evening when the frogs are active. Most species of frogs and toads can be located by their calls. Calling frogs can be located easily in the dark with the aid of a flashlight or headlamp. They are sometimes so intent upon calling and mating that they can be approached with ease, especially if it is warm. The breeding sites, of course, will yield tadpoles later in the year. Bullfrogs, Green Frogs and both species of spotted frogs are generally found close to permanent water, but Red-legged Frogs and Wood Frogs will forage in damp forest some distance from water. Tailed frogs are usually found in clear, fast-flowing mountain streams with lots of rocks and low amounts of sediment. Their tadpoles can be seen adhering to rocks in streams on sunny days. Adult tailed frogs are much more elusive, tending to remain hidden under rocks and logs along the streamside during the day, and becoming more active after dark. Other species of frogs and toads in British Columbia move further away from water outside the breeding season. Pacific Treefrogs and Western Toads inhabit meadows or damp woods. Great Basin Spadefoot Toads spend much of their time underground during the summer, but will emerge on humid nights.

When looking for frogs and toads, watch for movements on the ground. Approach the banks of ponds or sloughs slowly. Be patient. Try to observe the animal first to see how it behaves. Try not to stand up or move directly towards the frog but, instead, get down low and approach it obliquely and from behind to observe it. Using binoculars may help you spot a frog basking on shore before it gets spooked and leaps into the water. The ability to spot a frog, which usually blends in well with its surroundings, improves with experience. Binoculars can also help you scan the surface of the water for little twin bumps, the protruding eyes of a floating frog.

All species of turtles occurring in British Columbia are aquatic. The two marine turtles are only occasionally seen in the ocean and will not usually come ashore in our area. Freshwater turtles, such as the Painted Turtle, can be seen during sunny weather in ponds and lakes basking on logs or floating at the surface. Aquatic turtles may also occur in the mud at the bottom of bodies of water. Many species of aquatic turtles also make occasional overland treks, especially females during the nesting season, and can be seen crossing roads in daylight. During the breeding season, these turtles should not be disturbed as this may disrupt egg laying.

In Canada and other temperate regions, lizards tend to be diurnal yet fairly secretive. But in sunny weather they can be seen basking in the open. With their bodies warmed up, these lizards move quickly, making them more difficult to observe up close. When inactive, most lizards hide in burrows or rock crevices or under objects.

Some species of snakes, such as garter snakes and Racers, can be seen during the day but many, including the Rubber Boa, are secretive and often nocturnal, remaining hidden under rocks, logs and other objects. Where venomous snakes occur, cover objects should be turned over with care, preferably with a pole or a long tool rather than bare hands. Specialized tools are needed to capture venomous snakes safely and we strongly recommend that amateurs do not try to capture or handle such animals. Venomous snake bites can be severe. When walking in areas where venomous snakes occur, wear high-cut leather boots and similarly hard-to-penetrate clothing. Loose trousers not tucked into boots can also help decrease the probability of a bite penetrating the skin; the cloth may absorb some of the venom or prevent the fangs from reaching the skin.

Care of Captives

Many people develop an interest in herpetology by maintaining a few live reptiles or amphibians in captivity. The captive-bred animals available through pet stores are often bred for docility or living in captivity. It is always better to obtain pets from reputable breeders. Keeping captive-bred animals does not deplete native populations. Selling, trading or breeding any of our native species is illegal, but permits to collect and keep native amphibians and reptiles are issued for legitimate reasons to personnel from research and educational institutions.

The more common captive-bred amphibians and reptiles are usually not difficult to maintain. The first thing to do is to learn about the animal's habits, food preferences and habitat requirements. Then you can fashion a suitable environment and care for it properly. Amphibians and reptiles do not require constant attention; they may fare better if simply watched and left to themselves with a minimum of handling. They do, however, need proper surroundings and food. Unlike warm-blooded pets, such as cats and dogs, amphibians and reptiles often do not show signs of illness. One day they can appear healthy and the next day they may be dead. For further information on the care and feeding of captive amphibians and reptiles, consult the appropriate books available in libraries and pet shops.

Keeping an animal as a pet is a long-term commitment. Many species of amphibians and reptiles can live a long time, especially turtles and large snakes. Baby turtles are popular as pets, until they grow into big, voracious adults. Many people think that pets will remain small forever, and when they do not, would rather release them than care for them. Never release an animal in a foreign habitat; it will not likely survive and if it does, it can become a pest.

Released animals can spread diseases to native species, out-compete them or eat them. Problems with released species – Bullfrogs, Green Frogs and store-bought Red-eared Slider turtles – have already become severe in parts of British Columbia.

Never keep venomous snakes as pets. Foolish owners of rattlesnakes too often end up in the hospital, courtesy of their supposedly tame charges. Venomous snakes are dangerous animals that require special equipment and handling. Respect them and never become complacent or assume that a snake "knows" its owner.

All amphibians must have water and cannot be left in a completely dry cage. Terrestrial reptiles can more easily withstand dry conditions and may develop skin problems if they are constantly damp, but they should have access to fresh water in a bowl. Different species of amphibians and reptiles require different amounts of water. Amphibians do not drink but absorb water through their skin. They also lose water through their skin by evaporation. Standing water or moisture is essential. Use water from a reliably clean source, such as the pond or creek from which you collected the animal. Tap water frequently contains chlorine and other dissolved chemical compounds that can harm their sensitive skin. If no other water source is available, then allow the tap water to stand uncovered for at least 24 hours to allow chlorine and other dissolved gases to dissipate. An aquatic frog can be quite happy in an aquarium half full of water but for most terrestrial amphibians, like toads or newts, a shallow dish of water is sufficient. The water dish must not be so small or steep sided that the animal cannot sit entirely in the water or climb out. Toads can drown if they cannot get out of the water. Aquatic salamanders, tadpoles and pond turtles need deeper water. Some species need cool, constantly aerated water and thus are more difficult to maintain. Snakes will drink from a dish but lizards rarely do. Instead, lizards lap up water droplets, such as dew, easily applied by misting the tank regularly with water from a spray bottle.

An aquarium can make a fine home for an aquatic amphibian or a turtle. But an all-glass, watertight aquarium can be expensive and is really only necessary for aquatic species. Plastic tanks are relatively easy to clean, lightweight and durable. They can be fitted with a glass front and a screen top. Tiny specimens can live in a large jar with a screen top. Tanks are now available with locking lids, making them considerably more escape-proof and sanitary than homemade tanks. Wooden cages, for example, are difficult to keep clean and will rot with time. Snakes are proficient escape artists and should be kept in a container or tank with a secure lid, as they may be strong enough to push open a loose one. Be sure to provide adequate ventilation, but not with holes large enough for the animal to squeeze through. Use fibreglass screening for the cage top and the animals will be less likely to injure themselves.

The ideal landscape for a terrarium depends on the species kept in it. Toads need somewhere to dig. Salamanders and snakes need something to hide under. Treefrogs should have branches to climb on. There are limits to how naturally a terrarium can be landscaped though. A toad can uproot all the plants in its enclosure unless they are somehow protected from its burrowing. Keep the terrarium simple and do not crowd the animals. Amphibians and reptiles usually do best when alone as they may bite or eat each other if housed together. They do not get lonely. Although captive reptiles almost always need a close source of heat such as a light bulb or commercially available heating pad, amphibians should always be kept away from the heat and direct sunlight. Cool rooms are usually best for them. Some reptiles may sit directly on their heat source, seemingly oblivious to their burning skin. If this happens, you may have to move the heat source to just outside the tank. Commercial "hot rocks" can pose such problems, so it is better to use a light that is out of reach of the animal.

Different species of amphibians and reptiles eat different kinds of food. Frogs, toads and many lizards eat living, moving prey. If something does not move, it is not recognized as food. Salamanders, turtles, snakes and predaceous lizards are enticed by movement but they can also hunt by smell. Worms, slugs or insects can be collected from the garden. Crickets and mealworms can be bought at the pet store. Mealworms can also be cultured in bran or oats but they are low in some essential vitamins, as are store-bought crickets. A varied diet is best for a captive animal. If you are limited to store-bought insects, then just before feeding, dust the insects with vitamin supplements formulated for reptiles. These supplement powders are available through pet stores that carry exotic pet supplies. Salamander larvae need live, aquatic prey, which can be scooped up from the bottom of ponds or streams. Commercially available live or frozen brine shrimp or small bloodworms will do in their absence, but usually the best food to feed an animal is what it would get in the wild. Many snakes eat vertebrate prey, especially mice. Although mice can be frozen for later use, prolonged freezing depletes food of essential vitamins and nutrients and may also lead to rancid fatty acid build-up.

Tadpoles are easy to keep, but only until they transform into frogs or toads. Tadpoles can be fed a steady diet of boiled spinach or romaine lettuce, or algae from rocks, logs or leaves collected from a nearby clean, freshwater source. Metamorphosis can be rapid, and once it is complete – when the front legs appear – the little froglet is liable to drown unless it has land to crawl onto. Newly transformed froglets are extremely difficult to maintain because they require large numbers of very small, live insects to eat.

Know your animal and its needs before buying it. Some pet distributors and shops do not necessarily know the species or particular needs of the animals they stock. They might mislabel or misidentify a species, or fail to recognize health conditions about the animal. Some amphibians and reptiles have very specific dietary requirements, so food availability year round is essential in deciding which species to keep.

With a little care and effort, many amphibians and reptiles can survive for years in captivity and even reproduce. Much valuable behavioural information can be gained from observing a captive. But if you cannot properly care for an animal, do not release it away from its natural habitat. If it is not native to the area, contact an educational or research facility about donating it; a pet store may also accept it.

Scientific and Common Names

In this handbook, we use currently accepted scientific names, as well as the most appropriate common names, following the taxonomic catalogues *The Amphibians of British Columbia* (Green 1999), *The Reptiles of British Columbia* (Gregory and Gregory 1999) and the more recent paper, "Scientific and Standard English Names of Amphibians and Reptiles North of Mexico" (Crother et al. 2000, 2003). We also list, where appropriate, other common names of more limited acceptance or familiarity, as well as subspecies names. Unlike scientific names, which are internationally recognized but subject to change if the reasons are valid, common names are far from standard. Common names only incidentally reflect taxonomic relationships, are often regional and are usually changeable (for example, the Northwestern Garter Snake is sometimes referred to as the Red Racer). This leads to confusion when common names used for local species are also used elsewhere in the world for other species. The African Garter Snake (*Elapsoidea sundervallii*), for example, is more closely related to cobras than North American garter snakes and is highly venomous. Furthermore, the English language is not blessed with many names for amphibians – the four words "frog", "toad", "salamander" and "newt" cannot do justice to the immense variety of the world's amphibians.

Even some general common names can be confusing, because they have different meanings in different places. In Britain, a terrapin is a small aquatic or semi-aquatic turtle other than a sea turtle, but in North America, a terrapin is usually a turtle eaten by humans or kept as a pet. In this book, we use the word "turtle" for all members of the Order Testudines and "tortoise" for any land turtles of the Family Testudinidae.

Taxonomists give every species of living thing a Latinate scientific name to distinguish it from other species. In 1758, the Swedish botanist Carolus Linnaeus devised the universal classification system that biologists still use. The Linnaean system divides the animal kingdom hierarchically by phyla (singular: phylum), classes, orders, families, genera (singular: genus) and species (singular and plural). Other levels may be added between these, usually indicated by the prefixes "super" and "sub" (e.g., superfamily is a subdivision of an order and consists of one or more families). Determination of classification levels is traditionally based on morphology, but newer biochemical and molecular genetic methods have lately assumed great importance. In many instances in this book, we refer to members of a particular family by a shortened variation of its family name; for example, plethodontid salamanders belong to the family Plethodontidae, and colubrid snakes are members of the family Colubridae.

Most biologists recognize a species as being a lineage of interbreeding organisms or a population of organisms with its own unique evolutionary history. On a practical level, morphological features often provide enough diagnostic data to tell species apart but here too, biochemical and genetic information have recently come into greater use. For example, the Oregon Spotted Frog (*Rana pretiosa*) and the Columbia Spotted Frog (*R. luteiventris*) are nearly identical in morphology but have been distinguished from each other using biochemical genetics. Evidence of long-standing reproductive isolation and genetic distinctiveness, and not necessarily the degree of morphological similarity, is the criterion now used preferentially in recognizing the separation of species.

A scientific species name has two parts. The first word – always capitalized – indicates the genus to which the species belongs (e.g., typical frogs are in the genus *Rana* and humans are in the genus *Homo*). The second part of the name – never capitalized – indicates the species in the genus (e.g., *Rana aurora* and *Homo sapiens*). The genus name can be abbreviated if it has been mentioned previously and if the reference is obvious (e.g., *R. pipiens*). To properly refer to a species, you must use both parts of its scientific name and always write it in italics (or underline it, if italics are not available); but the names of the classification levels above genus are not italicized. If a subspecies exists, then the sub-specific name appears at the end to form a three-part name (e.g., *Thamnophis sirtalis fitchi*, Valley Garter Snake). Subspecies names frequently describe some morphological feature of the animal or indicate the animal's geographic origin.

Scientific names are usually based on Latin or Ancient Greek words. They can be descriptive, commemorative or, occasionally, whimsical. A formal scientific name is often appended with the name of the authority (the person who described the species) and the year the animal was described; but to avoid confusion in this book, we have not included the authority names and years with the species names.

A complete example of a species' common and scientific names: French-speaking people call the Wood Frog *la Grenouille des bois*, but to speakers of any language its scientific name is always *Rana sylvatica*. *Rana* is Latin for "frog" and *sylvatica* means "of the woods". The person who first described this species was Louis LeConte, so the formal scientific name is *Rana sylvatica* LeConte.

Studying Amphibians and Reptiles

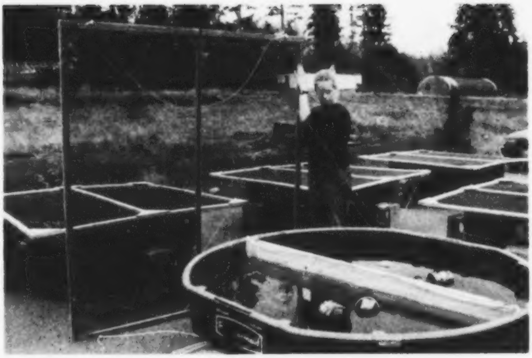
Why study amphibians and reptiles? These animals have little direct economic value, although some species provide food, leather or other products, or contribute to the control of insect and rodent pests. They have negligible direct effect on humans, unless one considers the extreme and unwarranted negative feelings many people have for snakes. Indirect effects are more difficult to assess.

The major reasons for studying amphibians and reptiles are interest and curiosity. Both collectively and individually, amphibians and reptiles demonstrate many unique features, as do all organisms, and are interesting for this reason alone. Their habits and life histories are of considerable interest to natural historians and they are frequently used for more general studies, such as physiology and evolutionary biology. Furthermore, amphibians and reptiles are ecologically important because of the roles they play in the energy flow of ecosystems.

Despite our small herpetofauna, herpetological work in British Columbia and Canada offers unique and interesting possibilities. Long overlooked, these animals are finally gaining the attention they deserve, with ongoing research continually adding to much-needed information to maintain their populations.

Although sophisticated population, behavioural and ecological research is usually done by professionals, a great deal of valuable information can be gathered with no more than enthusiasm and a good book for identification (like the one in your hands!). Large areas of British Columbia have never been properly surveyed for their amphibian inhabitants. These areas include much of the Pacific coast, the northern areas of the province and many mountainous regions. For instance, we do not know for certain if the Cascades Frog actually occurs in British Columbia, mainly because few people who could identify it have seriously looked for it here. The exact distributions of species in transitional areas such as Johnstone Strait, can only be determined with good locality information. This type of information gathering requires accuracy and objectivity. Records must include the date and exact place of capture, as well as the names of the collectors and habitat information. Locality records are valuable if the species are properly identified and accompanied by voucher specimens or good photographs that show identifying details for later confirmation.

A research site for the Coastal Tailed Frog, near the Chilliwack River. BRENT MATSUDA.



Heidy Peterson's research enclosures for Oregon Spotted Frogs at the University of British Columbia, Vancouver. BRENT MATSUDA.

New range information is invaluable. Reports of apparent range extensions and new locations should be made to the British Columbia Conservation Data Centre in Victoria. If possible, include detailed photographs of the animal and mark its exact location on the ground so that you can find it again. Immediately contact one of the people listed in the "Contact Information" section of this book, to confirm identification of your specimen. This person will know what to do or who else to contact if the specimen warrants further attention. In this case, the British Columbia Ministry of Environment should be contacted as well. Report all your observations, such as date, weather, habitat and numbers observed. If reporting on frogs or toads specifically, download and use record sheets available from the B.C. Ministry of Environment (Biodiversity Branch) Frogwatch website.

There are three major scientific societies in North America concerned with the biology of amphibians and reptiles. Membership in these societies is not expensive; consult their websites or the most recent issues of their journals for information. The American Society of Ichthyologists and Herpetologists publishes the journal *Copeia,* the Herpetologists' League publishes *Herpetologica,* and the Society for the Study of Amphibians and Reptiles publishes both the *Journal of Herpetology* and *Herpetological Review.* These journals publish academic, rather than popular, articles. The Society for Northwestern Vertebrate Biology publishes a journal called the *Northwestern Naturalist* that often features amphibian and reptile research relevant to northwestern North America. There are a number of other journals that contain the results of herpetological research, including *Amphibia-Reptilia, Applied Herpetology, Canadian*

Field-Naturalist, Canadian Journal of Zoology, Conservation Biology, Ecology, Evolution, Herpetological Journal, Herpetological Natural History and *Northwest Science*. In addition, the Canadian Amphibian and Reptile Conservation Network publishes a newsletter called the *Boreal Dipnet*. Although these specialized journals are unlikely to be available in most public libraries, past and present issues can be found in university, college and museum libraries.

Further information on amphibians and reptiles can be found in the books and journals listed at the back of this book. There are a number of websites that provide relevant information on amphibians and reptiles, wetland surveys and survey dataforms. Websites maintained by the B.C. Ministry of Environment, Frogwatch BC, the North American Amphibian Monitoring Program, and the societies previously mentioned are good places to start.

Canadian museums with substantial collections of British Columbian amphibians and reptiles are the Royal British Columbia Museum in Victoria, the Canadian Museum of Nature in Ottawa, the Royal Ontario Museum in Toronto and the Cowan Vertebrate Museum at the University of British Columbia in Vancouver. The Vancouver Aquarium Marine Science Centre in Stanley Park, Vancouver, also features educational displays of some of British Columbia's native amphibians and reptiles, as well as exotic species.

CHECKLIST AND CONSERVATION STATUS

This checklist of amphibians and reptiles in British Columbia also shows the provincial and federal conservation status for each species as of January 2005. Provincial status (BC) is designated by the British Columbia Ministry of Environment:

R = Red List (threatened/endangered).
B = Blue List (vulnerable).
Y = Yellow List (not at risk in British Columbia).
I = introduced.

Federal status (CAN) is designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and listed under the Species at Risk Act:

XT = extirpated from Canada.
E = endangered.
T = threatened.
SC = special concern.
NAR = not at risk.

COSEWIC gives priority to assesment of species suspected to be at risk. If no status is given, the species has not been assessed.

Common Name (Scientific Name)	Status BC	Status CAN
Salamanders		
☐ Rough-skinned Newt (*Taricha granulosa*)	Y	
☐ Coastal Giant Salamander (*Dicamptodon tenebrosus*)	R	T
☐ Long-toed Salamander (*Ambystoma macrodactylum*)	Y	
☐ Northwestern Salamander (*Ambystoma gracile*)	Y	NAR
☐ Tiger Salamander (*Ambystoma tigrinum*)	R	E
☐ Western Red-backed Salamander (*Plethodon vehiculum*)	Y	NAR
☐ Coeur d'Alène Salamander (*Plethodon idahoensis*)	B	SC
☐ Ensatina (*Ensatina eschscholtzii*)	Y	NAR
☐ Wandering Salamander (*Aneides vagrans*)	Y	
Frogs and Toads		
☐ Coastal Tailed Frog (*Ascaphus truei*)	B	SC
☐ Rocky Mountain Tailed Frog (*Ascaphus montanus*)	R	E
☐ Great Basin Spadefoot Toad (*Spea intermontana*)	B	T
☐ Western Toad (*Bufo boreas*)	Y	SC
☐ Pacific Treefrog (*Hyla regilla*)	Y	
☐ Boreal Chorus Frog (*Pseudacris maculata*)	Y	
☐ Red-legged Frog (*Rana aurora*)	B	SC
☐ Columbia Spotted Frog (*Rana luteiventris*)	Y	NAR
☐ Oregon Spotted Frog (*Rana pretiosa*)	R	E
☐ Wood Frog (*Rana sylvatica*)	Y	
☐ Northern Leopard Frog (*Rana pipiens*)	R	E
☐ Green Frog (*Rana clamitans*)[1]	I	
☐ Bullfrog (*Rana catesbeiana*)[1]	I	
☐ Cascades Frog (*Rana cascadae*)[2]		
Freshwater Turtles		
☐ Western Pond Turtle (*Clemmys marmorata*)	R*	XT
☐ Painted Turtle (*Chrysemys picta*)	B	
☐ Asiatic (Chinese) Turtle (*Chinemys reevesi*)[1]		
☐ Pond Slider (*Trachemys scripta*)[1]	I	
☐ Snapping Turtle (*Chelydra serpentina*)[1]		

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* Considered extirpated in British Columbia.

[1] Introduced to British Columbia.

[2] Possibly occurs in B.C., but not yet recorded.

Common Name (Scientific Name)	**Status**	
	BC	**CAN**
Marine Turtles		
☐ Green Turtle (*Chelonia mydas*)[3]		
☐ Leatherback Sea Turtle (*Dermochelys coriacea*)	R	E
☐ Olive Ridley (*Lepidochelys olivacea*)[2]		
Lizards		
☐ Pigmy Short-horned Lizard (*Phrynosoma douglasii*)	R*	XT
☐ Common Wall Lizard (*Podarcis muralis*)[1]	I	
☐ Western Skink (*Eumeces skiltonianus*)	B	SC
☐ Northern Alligator Lizard (*Elgaria coerulea*)	Y	NAR
Snakes		
☐ Rubber Boa (*Charina bottae*)	Y	SC
☐ Sharp-tailed Snake (*Contia tenuis*)	R	E
☐ Night Snake (*Hypsiglena torquata*)	R	E
☐ Racer (*Coluber constrictor*)	B	SC
☐ Gopher Snake (*Pituophis catenifer*)	B	T
☐ Common Garter Snake (*Thamnophis sirtalis*)	Y	
☐ Northwestern Garter Snake (*Thamnophis ordinoides*)	Y	NAR
☐ Western Garter Snake (*Thamnophis elegans*)	Y	
☐ Western Rattlesnake (*Crotalus oreganus*)	B	T

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* Considered extirpated in British Columbia.

1. Introduced to British Columbia.
2. Possibly occurs in B.C., but not yet recorded.
3. Accidentally occurs in B.C.

SPECIES ACCOUNTS

These accounts cover native species and introduced species that have established breeding populations in the province; occasional, accidental and other introduced species are discussed in a section following the species accounts. Each account describes the species, highlighting distinguishing features, and gives information on habits, breeding, subspecies and range.

The size measurements for each species are given as the total length or snout-vent length, in millimetres (mm). The standard measurement for amphibians and reptiles is the snout-vent length: from the tip of the snout to the vent. For a frog or toad, this is the same as the total length, but for a salamander, lizard or snake, it omits the length of the tail. Herpetologists use the snout-vent length because salamanders and lizards can lose all or part of their tail and then re-grow it. The total length, while less reliable for some species, gives a better idea the animal's size. In this book, if we say that an animal is 110 mm long, we mean its total length. Sometimes we give the length of the tail as a proportion of the total length. Turtles are usually measured by their shell length.

Each account includes a distribution map showing all the places where the species has been recorded in British Columbia. Black dots indicate native populations and open circles mark the locations of introduced populations. The maps are as up-to-date and as accurate as possible, based on historical knowledge and the observations and records that we have compiled.

In writing the accounts of species that live in this province, we have gathered as much information as possible about British

Columbian populations. For some of our native species little research has been done, so we have used information collected from populations in the United States and other parts of Canada. We have tried to make it clear which aspects of the biology of our various species are poorly known. This provides opportunities for interested people to share their observations and help shed light on these animals, especially on their distribution. Some of the distribution maps in this book show obvious gaps in our knowledge of species ranges.

We provide diagnostic keys to help identify species – separate keys for salamanders and newts, frogs and toads, turtles, lizards, and two for snakes – designed specifically for use in British Columbia. A key is a series of numbered pairs of statements to be compared with the specimen in question. Each choice of the statement pair leads either to another pair of statements or, ultimately, to a positively identifying statement for a particular species. Start with the first pair of statements and decide whether "a" or "b" better describes your specimen. The statement you choose will either give you the name of the species or direct you to another pair of statements. Follow this process until you reach an identification. With practice, a key is not difficult to use, and each key in this book concerns just a few species. Most of the pertinent anatomical features are illustrated in the keys; unfamiliar terms are defined in a glossary at the back of the book. The keys are "artificial" in that they do not necessarily reflect the true taxonomic affinities of the various species, nor do they use the same characteristics that biologists would necessarily use in classifying the species.

One of the characteristics of amphibians is that most species have aquatic larvae (tadpoles) that differ considerably from the adults. We describe larvae in the species accounts, but do not illustrate all of them. We give more details of the larval stage for species of salamanders whose individuals do not necessarily transform into terrestrial adults. In many cases, amphibian larvae can be very difficult to identify. Corkran and Thoms 1996 provides a more detailed key for amphibian larvae in British Columbia.

Measuring the length of an adult Coastal Tailed Frog.
BRENT MATSUDA.

The accounts, maps and keys should enable you to identify any of the amphibians and reptiles living in British Columbia.

At the end of each account, we cite publications from the scientific and technical literature to provide you with sources of more detailed information. These sources are listed in the References section of the Bibliography at the end of the book, which focuses on more current references or those particularly relevant to British Columbia. There is also much useful information in older publications, many of which are cited in the publications we have listed.

AMPHIBIANS

Salamanders

Salamanders are found across the northern hemisphere and into the tropics of South America but the majority of salamander species occur in North America and Central America. There are ten recognized families of salamanders living today, four of which occur in British Columbia. Salamanders range in size from the Chinese Giant Salamander (*Andrias davidianus*) that can reach 1.5 metres long to Central America's tiny lungless salamanders (*Thorius* species) that grow to only a few centimetres.

Many of the largest salamanders are entirely aquatic. Among these, the mudpuppies and the sirens of eastern North America retain the external gills of their larval stage even though they grow very large. Sirens never even grow hind legs. Some aquatic salamanders have adapted to living in caves. These species typically have tiny eyes and have lost their skin pigmentation, which makes them appear ghostly white. Many newts are highly aquatic as adults and some salamanders, including the Coastal Giant Salamander and Northwestern Salamander, may transform into terrestrial adults or remain in an aquatic larval form, with external gills, even after sexual maturity.

In contrast, some salamanders are entirely terrestrial. Some, like British Columbia's plethodontid species – the Western Red-backed Salamander, Ensatina, Coeur d'Alène Salamander and Wandering Salamander – rarely or never enter water and do not have aquatic larvae.

A typical salamander is elongated and smooth-skinned with four legs and a long tail; each side has a series of vertical costal grooves. Most salamanders have four toes on the front feet, five toes on the hind feet and no claws. A newt is a kind of salamander in the family Salamandridae. Newts usually have rougher skins than other kinds of salamanders and their costal grooves are not distinct.

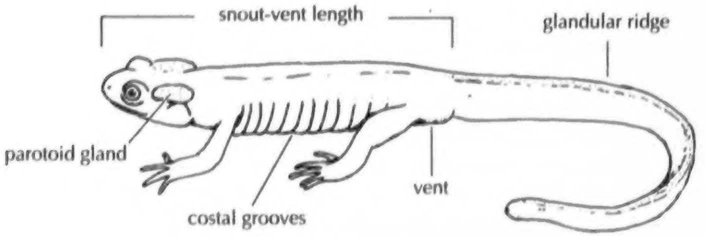
Salamanders can have teeth not only along the jaws but also on the roof of the mouth. Vomerine teeth are usually in two rows located just behind the internal openings of the nostrils. Parasphenoid teeth, characteristic of plethodontid salamanders, are in a cluster on the roof of the mouth. These kinds of teeth are named after the skull bones to which they are attached.

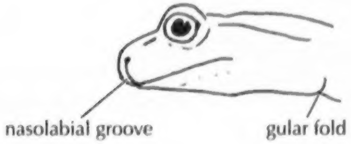
Selected References: Duellman and Trueb 1994, Petranka 1998, Stebbins and Cohen 1995.

Key to Terrestrial Salamanders of British Columbia

1a. Skin rough and tuberculate; belly bright orange; no obvious costal grooves ...... Rough-skinned Newt (*Taricha granulosa*)
lb. Skin smooth; costal grooves evident 2

2a. Nasolabial groove running down from each nostril (difficult to see in some species); parasphenoid teeth present 3
2b. No nasolabial grooves or parasphenoid teeth 7





3a. Yellow, orange or red dorsal stripe continuing to tip of tail . .4
3b. No dorsal stripe 5

4a. Smooth edged red, orange or yellowish dorsal stripe continuing to tip of tail; 15 costal grooves on each side of the body . . .Western Red-backed Salamander *(Plethodon vehiculum)*
4b. Irregular yellow to orange-red dorsal stripe broken into patches on the head; 14 costal grooves on each side of the body . . . . . . .Coeur d'Alène Salamander (*Plethodon idahoensis*)

5a. Tail constricted at base; yellow colour at limb bases; no markings on back; 12 costal grooves on each side of the body . . . . .Ensatina *(Ensatina eschscholtzii)*
5b. Tail not constricted at base; no yellow at limb bases; 15 costal grooves on each side of the body 6

6a. Mottled colour pattern; square toe-tips . . . . .Wandering Salamander (*Aneides vagrans)*
6b. Uniform grey or charcoal colour; rounded toe-tips . . . . . .Western Red-backed Salamander *(Plethodon vehiculum)*

7a. Irregular green or yellow dorsal stripe breaking up on the head and tail; white speckles on sides and belly; 12 costal grooves on each side of the body; second toe from the outside on each hind foot longer than other toes . . . . .Long-toed Salamander (*Ambystoma macrodactylum)*
7b. No dorsal stripe; length more than 120 mm 8

8a. Blotched yellow (or white) and black pattern; foot tubercles present; 13 costal grooves on each side of the body . . . . .Tiger Salamander (*Ambystoma tigrinum)*
8b. Foot tubercles absent 9

9a. Dark brown to black or grey, with or without black specks; parotoid glands and glandular ridge on tail present; 10 to 12 costal grooves on each side of the body . . . . .Northwestern Salamander (*Ambystoma gracile)*
9b. Marbled brown pattern; no parotoid glands or glandular ridge on tail; 12 costal grooves on each side of the body . . . . .Coastal Giant Salamander (*Dicamptodon tenebrosus*)

FAMILY SALAMANDRIDAE

Rough-skinned Newt *Taricha granulosa*

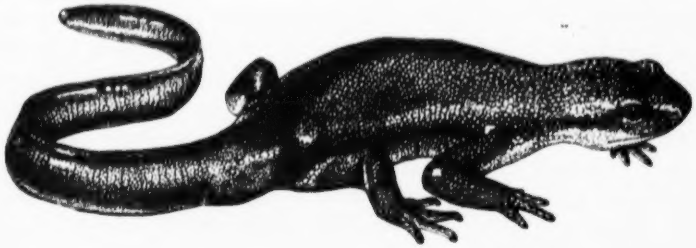
Other Names: Pacific Coast Newt, Roughskin Newt, Western Newt.

Although all amphibians possess some sort of noxious or poisonous skin secretions for defence, this newt and related species in the same genus have by far the most potent skin toxin of any North American amphibian. The active ingredient, *tetrodotoxin* (the same toxin found in puffer fish), swiftly blocks nerve impulses if experimentally injected. But Rough-skinned Newts are docile and engaging animals; the poison is purely for defence, released only if the newt is extremely agitated. As a precaution though, wash your hands after you touch a newt, and don't eat them!

Description

This is a long-legged, solid brown, black or dark-olive salamander with slightly flat fingers and toes. The entire body surface is rough with small tubercles. In its terrestrial phase the Rough-skinned Newt is dry to the touch, in contrast to other salamanders, which are smooth and often slippery, even as adults. The small eyes have yellow irises and do not protrude much above the head. The jaws jut out at the back of the head, making the head look square. The throat has no gular fold. The belly is orange and unmarked. The tail is compressed laterally towards the tip. See colour photograph 2.

Male newts can be distinguished from females by their longer tail, longer legs, and a more swollen vent with the dorsal pigment usually extending across it as a dark band. The differences between the sexes become accentuated in the breeding season: males



become more aquatic; they develop smoother skin, an enlarged tail fin, and dark nuptial pads on the palms, soles and legs; and their vent swells even more. Females do not experience these changes. Rough-skinned Newts can be 120 to 185 mm long, with the tail taking up about five-eighths of a male's length and about three-eighths of a female's.

Newt larvae are aquatic. They have blunt heads. Later in development, single rows of yellowish dots appear along the sides and sometimes along the margin of the head. Very young larvae have balancers protruding from behind the head. They transform in late summer when about 50 to 70 mm long, although at high altitude and high latitude sites some larvae overwinter and metamorphose the following year.

Distinguishing Features: Newts, in general, can be distinguished from other salamanders by the lack of distinct costal grooves on the side of the body. The Rough-skinned Newt is easily identified by its bright orange belly and uniformly dark back.

Habits

Rough-skinned Newts can be common in mixed forests, usually near permanent ponds or swamps. They inhabit older or mature forests with a good deal of deadfall and litter, but they are rare in dense, damp cedar forests. Newts are not as secretive as other salamanders, and although they are primarily nocturnal, they can be active in the daytime, especially on warm, cloudy or rainy days. They can be aquatic, especially in the breeding season. In some populations outside British Columbia, neotenic newts remain aquatic their whole lives, retaining their external gills into adulthood. They can occur in dense aggregations of dozens or even hundreds of animals in a limited volume of water.

Rough-skinned Newts move slowly and make little attempt to hurry if they are bothered. When struck or grabbed they will arch their backs, bringing the tail and head up to expose their bright orange bellies, and remain immobile in that position. They make no attempt to bite. Their toxic skin secretions are enough to prevent almost any predator from trying more than once to eat one and they preclude any necessity to protest more vigorously. Elsewhere in their range, humans have died after swallowing a newt, but this is rare. The only known predator on the Rough-skinned Newt throughout most of its range is the Common Garter Snake, which has evolved a heightened resistance to tetrodotoxin.

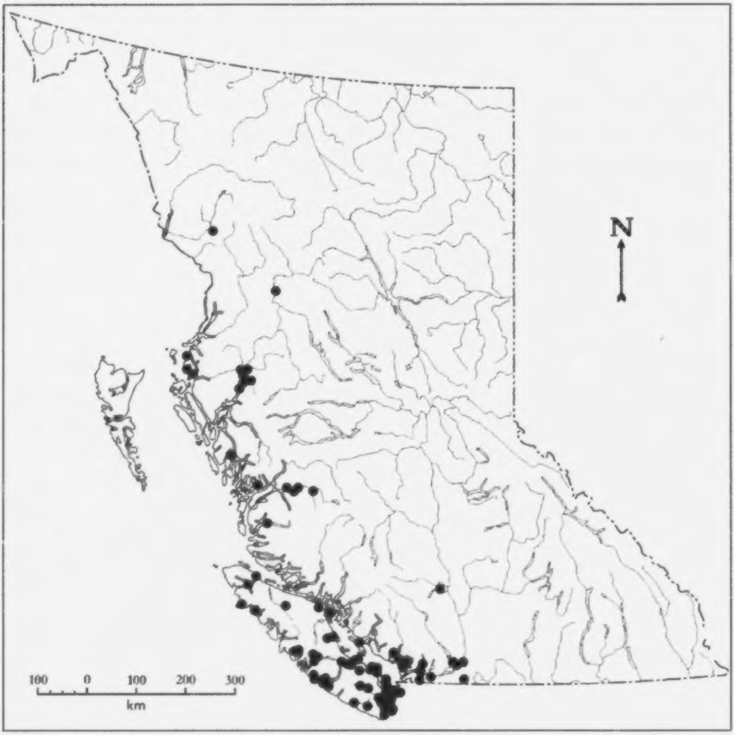
Tetrodotoxin has not been found in Rough-skinned Newts on Vancouver Island and toxicity levels have yet to be determined for British Columbian mainland newts. Correspondingly, Common Garter Snakes on Vancouver Island are not resistant to tetrodotoxin even though they feed on Rough-skinned Newts. But newts can secrete more than one toxin, which in some cases still causes a snake to become ill.

Rough-skinned Newts eat whatever small, bite-sized animals they can catch, including amphipods, insects of all sorts, leeches, clams, tadpoles and slugs. They will also eat amphibian eggs, including those of their own species.

Breeding

Rough-skinned Newts breed in early spring in shallow ponds, bogs, swamps and slow-moving streams. Neotenic individuals may begin breeding in late fall. Large numbers of newts will migrate to their breeding sites on warm, rainy nights in spring. As in many salamanders, the courtship of Rough-skinned Newts is an elaborate ritual. Both sexes enter the water, and a male in breeding condition will locate a female mainly by smell. When he finds a mate he will grab her in pectoral amplexus, which can last from four hours to four days. In this position, riding on top of the female, the male will stroke her sides with his hind feet while rubbing his chin on her nose. There is a gland on the male's chin whose secretion contains a pheromone that plays a role in synchronizing the behaviour of both sexes during courtship. With his powerful tail, the male can control the female and manoeuvre her away from other males. If unsuccessful, many males will try to grab the same female. Eventually, if the courtship is successful, the male will let go of the female and dismount, swimming ahead to position himself in front of and perpendicular to her. As the female nudges his vent he deposits a spermatophore on the ground. The male then creeps forward and bends his body to guide the female with his tail into the proper position for her to pick up the spermatophore packet with her cloaca. The male thereupon resumes amplexus with the same female or goes off in search of another.

Shortly after mating, the female lays pigmented eggs as gelatinous capsules attached singly to aquatic plants or the undersides of submerged rocks. The eggs hatch in 20 to 26 days. The larvae eat small aquatic invertebrates and may take one or two seasons to transform.



Subspecies: There are two subspecies and only the Northern Rough-skinned Newt (*Taricha granulosa granulosa*) occurs in British Columbia.

Range

Rough-skinned Newts are found along the western coast of North America west of the Coast and Cascade mountains from near Anchorage, Alaska, to San Francisco Bay. An isolated population also exists in northern Idaho, and single specimens have been reported in Montana and eastern Washington. In British Columbia, Rough-skinned Newts inhabit the forests of Vancouver Island, the Gulf Islands and the entire mainland coast as far north as Echo Lake and the Skeena River, extending up major river valleys.

Selected References: Hanifin et al. 1999, Janzen and Brodie 1989, Marangio 1978, Propper 1991, Taylor 1984.

FAMILY DICAMPTODONTIDAE

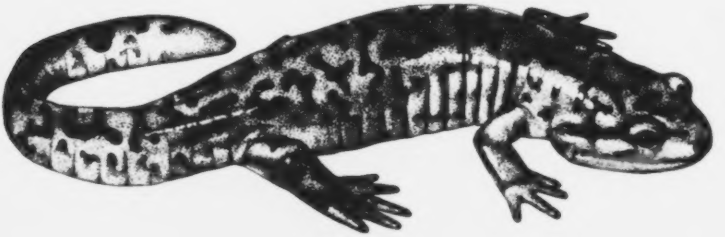
Coastal Giant Salamander
Dicamptodon tenebrosus

Other Names: Pacific Giant Salamander.

The family Dicamptodontidae contains the largest terrestrial salamanders in North America and the Coastal Giant Salamander is the largest of these. Its larvae are streamlined and adapted to life in flowing water.

Description

This large, robust salamander has light and dark brown to gold markings on the head, back and sides that form a reticulated marbled pattern. Light halos may surround the dark patches. Sometimes, in older animals, this pattern can be faded, making a salamander appear more uniformly black. The belly is a light tan or flesh tone. The moderately broad head has a short, blunt snout and medium-sized eyes that have brass-flecked irises. A gular fold is present. There are no parotoid glands. The body is stout and the legs large and strong. The feet do not have webs and do not have any tubercles on the soles. The skin at the tips of the toes may be cornified (hardened). This salamander generally has 12 indistinct costal grooves on each side on the body. Adpressed limbs overlap. The tail is stout and laterally compressed towards the tip. Males have slightly longer tails than females. This is the largest salamander in British Columbia and can reach a length of 300 mm, although most full-grown adults reach 150 to 250 mm long. The tail is about two-fifths of the total length. See colour photograph 4.

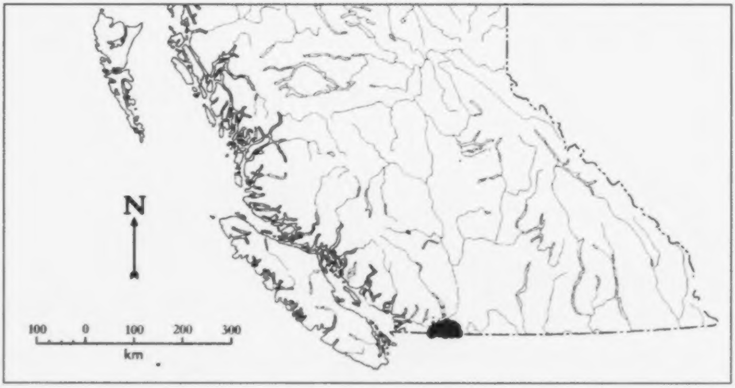


The larvae of the Coastal Giant Salamander live in streams. They have small, fuzzy gills behind the head and a short fin confined to the tail. They are light chocolate-brown or black without obvious markings, except for a light stripe that extends from the eye to the angle of the jaw. The face is short and broad; fleshy flaps on the upper jaw overlap the lower jaw on each side of the mouth. Larvae transform at five or six years of age when 150 to 200 mm long, if they transform at all. Neoteny is common in this species and permanently aquatic individuals can grow large and reach sexual maturity while retaining larval form and colouration. See colour photograph 3.

Distinguishing Features: Any large salamander from the hills surrounding the Chilliwack River valley with prominent light and dark brown or gold marbled markings is certain to be a Coastal Giant Salamander. No parotoid glands or foot tubercles. The large larvae have smaller gills in proportion to their body size than other larval salamanders. Aquatic neotenic adults are seen more often than terrestrial adults.

Habits

Coastal Giant Salamanders dwell in the Douglas-fir (*Pseudotsuga menziesii*) and Big-leaf Maple (*Acer macrophyllum*) forests of the hills and mountains surrounding the Chilliwack River valley. Transformed terrestrial adults rarely venture far from clear, fast-flowing creeks. They forage openly at night and occasionally during daylight in wet weather, but they spend much of their time



hiding under logs and rocks, making them difficult to find. Coastal Giant Salamanders dig well, but often follow small animal burrows and cracks that extend underground. Their large size makes them appear quite formidable. They are harmless to humans, even if they do try to bite. Their food includes slugs, insects, frogs, other salamanders and the occasional small mammal; larger Coastal Giant Salamanders may also eat garter snakes.

The larvae of the Coastal Giant Salamander inhabit cold, clear, fast-flowing, unsilted streams. The larvae and neotenic adults are voracious predators of other amphibian larvae such as the tadpoles of the Coastal Tailed Frog, whose habitat they share in the Chilliwack River valley.

Breeding

Coastal Giant Salamanders breed from spring to autumn. Their courtship pattern is not fully known. Males deposit many spermatophores during courtship, similar to those of many ambystomatid salamanders. Females only breed every second year. The female will lay 85 to 200 eggs, attaching them one at a time or in clumps to the underside of a rock in a creek or stream. The colourless eggs remain attached to the rock by a small pedicle or stalk. The female stays with her eggs, sometimes for up to seven months, brooding and protecting them during their development until they hatch in the fall. In British Columbia, the larvae grow slowly and transform in their fifth or sixth year, if at all; they can take several more years to reach sexual maturity. Individuals can live 20 years or more.

Subspecies: None.

Range

Coastal Giant Salamanders are found along the west coast of North America from extreme southern British Columbia to northwestern California. In British Columbia, they are known only from the Chilliwack River valley, in several creeks draining into the river between and immediately surrounding Cultus and Chilliwack lakes.

Selected References: Blood 1993a, Ferguson 2000, Johnston 1998, Johnston and Frid 2002, Jones et al. 1990, Parker 1994.

FAMILY AMBYSTOMATIDAE

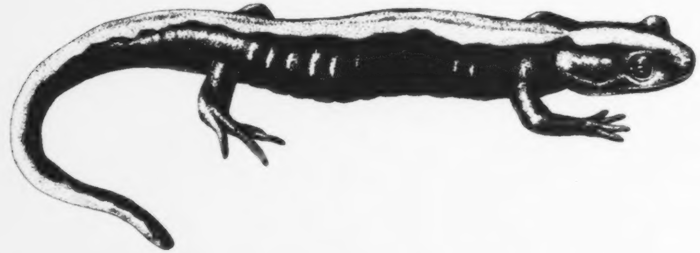
Long-toed Salamander
Ambystoma macrodactylum

Adult ambystomatid salamanders, such as the Long-toed Salamander, are rarely seen except during breeding season, largely because they spend most of their time underground or hidden underneath rocks or downed wood. This is why members of the family are sometimes called mole salamanders, though they have limited burrowing abilities; instead, they often hide in the abandoned burrows of rodents or in natural hollows and crevices. The Long-toed Salamander is the most widely distributed salamander species in British Columbia.

Description

The Long-toed Salamander is named for the exceptionally long toe, second from the outside, on each hind foot. It is a dark grey or black salamander, with a prominent but irregular stripe of green or yellow running down the back from the top of the head and along the tail. In southwestern British Columbia and on Vancouver Island, the dorsal stripe is usually greenish with diffuse and indefinite edges; in the Rocky Mountain region, it tends to be a bold, bright yellow, breaking into patches on the head; and in the rest of the province, it is a continuous yellow from the tip of the snout to the tail. The salamander's sides and belly are lighter grey with numerous white speckles. The head is oval, with a blunt snout and large, prominent eyes, but no parotoid glands. The neck has a gular fold. The legs are strong, and the feet have slender, unwebbed toes and small tubercles on the soles. There are usually 12 costal grooves on each side of the body. Adpressed limbs either meet or overlap by up to two costal grooves. This medium-sized salamander is 80 to 160 mm long, with the tail occupying a little more than half its length. Males have a slightly longer tail and a larger vent than females. Juveniles are often more brightly coloured than the adults and have fewer white speckles on the sides and belly. See colour photograph 5.

The larvae live in ponds. They are grey or light brown, and flecked with darker brown or black; the underside is silvery. They have a large head and broad snout. See colour photograph 6.



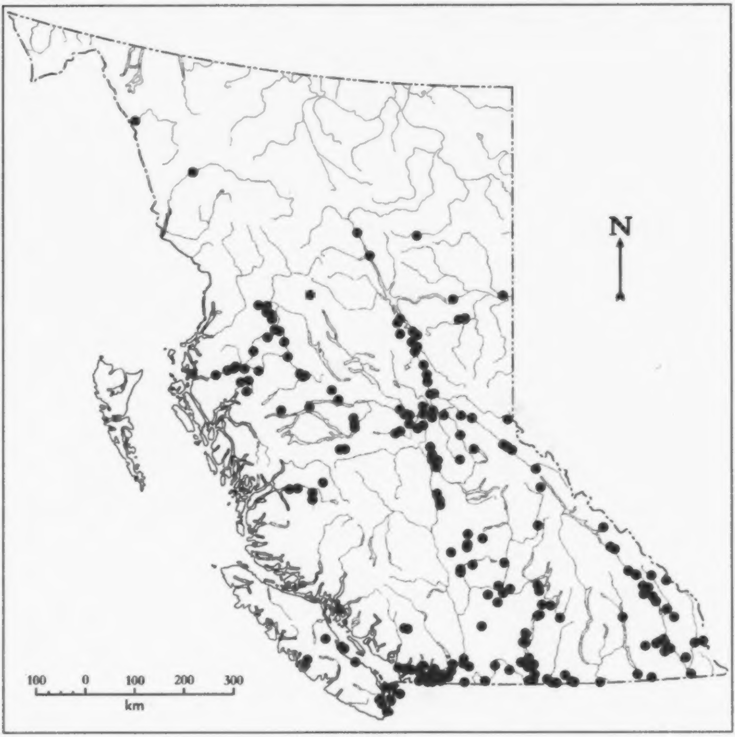
Distinguishing Features: The irregular light-green or yellow stripe on the back that breaks up into spots and patches before it reaches the tip of the tail. The exceptionally long toe on each hind foot. Adpressed limbs meet or overlap by up to two costal grooves. No nasolabial groove.

Habits

The Long-toed Salamander is at home in a variety of habitats but prefers damp areas in forests and meadows where there are ample opportunities to hide, generally not far from water. Adults remain hidden throughout most of the year underneath rocks, logs or boards, in abandoned burrows, or in crevices in rock piles. Occasionally they wander into basements or cellars through foundation cracks or open windows. Most of their activity above ground occurs in the spring or fall during wet weather. The food of the Long-toed Salamander consists of small invertebrates and insects. Larvae may feed on small Pacific Treefrog tadpoles in pools that they share, or other smaller, Long-toed Salamander larvae. The adults serve as food for a number of predators, including garter snakes, fishes and small mammals.

Breeding

The Long-toed Salamander breeds earlier in the year than most amphibians, in the early spring often before the ice on the breeding ponds has completely disappeared. The Long-toed Salamander breeds in shallow pools that usually have a fair amount of aquatic vegetation. The courtship pattern is similar in some ways to that of the Rough-skinned Newt and Northwestern Salamander. The male will unceremoniously grab a female in pectoral amplexus and rub his chin on her nose so that she will smell the secretions of his chin gland; but he does not use his hind legs to hold onto the female, as do some male Northwestern Salamanders. After a while, the male



breaks off amplexus, and moves about one body length ahead of the female to deposit a spermatophore. Then he leads the female forward so that she can pick it up. Once this performance is finished, the male either moves on to find another mate or turns around and grabs the same one again. A male can deposit many spermatophores during a round of courtship and mating.

The female lays up to 60 eggs soon after mating. She sometimes lays them singly, but usually in small clumps attached to underwater vegetation. The eggs hatch in two or three weeks. At high elevations and in northern regions of British Columbia, where water temperatures remain cool, larvae may overwinter and transform the following summer. In most cases though, larvae will metamorphose during their first summer. Long-toed Salamanders reach maturity in two or three years.

Subspecies: The Long-toed Salamander has five subspecies, three of which occur in British Columbia: the Western Long-toed Salamander (*Ambystoma macrodactylum macrodactylum*) occurs on the lower Fraser River valley and Vancouver Island; the Northern Long-toed Salamander (*A.m. krausei*) occurs in the eastern part of the province in the Rocky Mountain region; and the Eastern Long-toed Salamander (*A.m. columbianum*) occupies the rest of the species' range in British Columbia, in between the other two.

Range

Long-toed Salamanders have been found from sea level to over 2400 metres elevation from southern Alaska across most of British Columbia west of and including the Rockies, through Washington, Idaho and western Montana to Oregon and northern California. They inhabit most of British Columbia as far north as the Peace River in the east and the Taku River in the west, but not on northwestern Vancouver Island and the Queen Charlotte Islands.

Selected References: Carl 1942, Fukumoto and Herrero 1998, Funk and Dunlap 1999, Howard and Wallace 1985, Tallman et al. 2000.

Northwestern Salamander *Ambystoma gracile*

Other Names: Brown Salamander.

Description

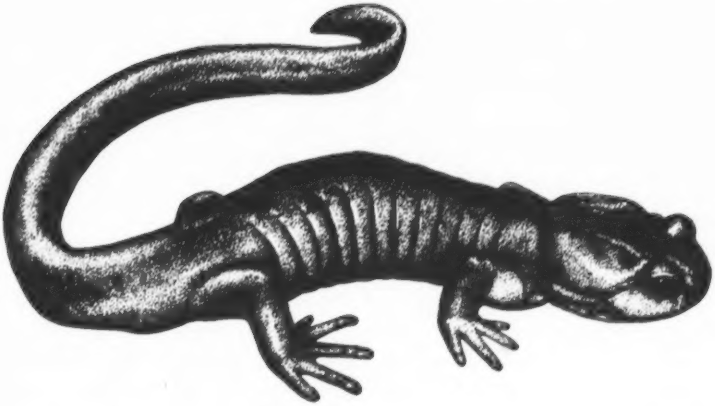
The Northwestern Salamander is large and chunky, and chocolate-brown to dark reddish, though it may have patches of white to yellowish specks (more common among individuals in the northern parts of the range). The belly is a light shade of brown. The head is wide with small, slightly protuberant brown eyes. The large, oval parotoid glands are usually obvious and bounded by indented grooves. The glands are slightly paler than the rest of the body and have tiny pits (pores) on their surface. Each side of the body has 10 to 12 costal grooves. The legs are well-developed and will overlap by about 6 costal grooves when adpressed. The laterally compressed tail has a glandular ridge that is similar in appearance to the parotoid glands and runs along the top of the tail. The soles of the feet have no tubercles. A female Northwestern Salamander can grow up to 250 mm long and a male about 230 mm; the tail makes up about half a female's length and slightly more than half a male's length. Males also tend to have longer legs than the females and in the breeding season they develop a swollen vent. See colour photograph 8.

The larvae have large, feathery gills and a large tail fin that extends forward along the back as far as the head. They are brown, grey or nearly black, and often overlaid with irregular yellow to cream flecks or spots, or with dark blotches. They also have a glandular ridge on the tail. Larvae can grow up to 185 mm long.

Distinguishing Features: The robust form and dark colour. Distinct parotoid glands. The glandular ridge along the top of the tail.

Habits

Adult Northwestern Salamanders are elusive and rarely seen. They seem to prefer forest margins and pond banks, but they spend most of their time hidden in or under leaf litter, rotten logs or boards. Terrestrial forms tend to be most active during rainy weather in the spring and fall, especially during the breeding season when they are migrating to breeding ponds. They are mainly nocturnal. When severely disturbed, a Northwestern Salamander will exude a sticky and foul-tasting milky white poison through



the pores of its parotoid and tail glands. It may assume a defensive posture by rising up on its legs while lowering its head and lashing its tail back and forth, twisting and seething to rub the glandular regions on the attacker. Males may emit a "tic" sound when defending themselves or breeding aggressively; aquatic larvae do not exhibit this behaviour. These salamanders eat a variety of food items, including tadpoles and invertebrates such as slugs, flies and amphipods.

The larvae of the Northwestern Salamander are seen more often than the adults through most of the year. Larvae can be found at any time of the year because they generally take more than one season to transform, if they transform at all. Neotenic individuals breed at the same time as transformed individuals and the two forms will mate with each other. Neoteny in this species is common and usually related to environmental conditions. It is most frequent among salamanders living in large, stable ponds or in lakes, especially at high altitudes.

Breeding

Adults migrate to shallow, moderately vegetated ponds or lakes in early spring to breed, but in high-altitude and northern ponds, breeding can occur as late as July. They require permanent or semipermanent ponds located near woodlots or forests. The ponds are usually devoid of predatory fishes that might eat the eggs or growing larvae. In the water, the male grabs a female in amplexus with one or both pairs of legs and repeatedly rubs his chin over her nose; he sometimes dismounts and nudges or butts her with his

Northwestern Salamander eggs.
PATRICK GREGORY.

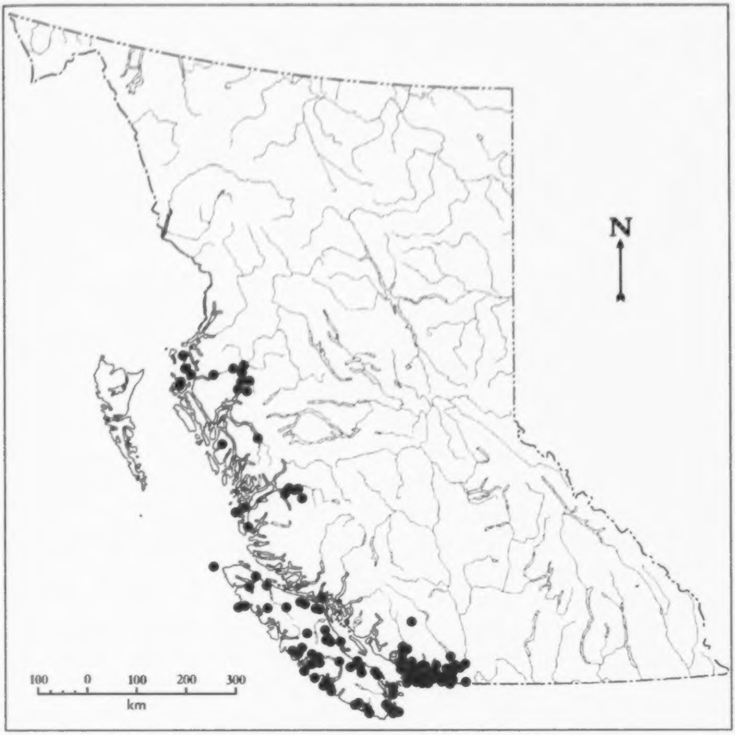
head. After the male swims forward and deposits his spermatophore on the pond bottom, he gently strokes the female with his tail while she picks it up. A single male can deposit up to 30 spermatophores.

Later, the female lays an average mass of 50 eggs that will swell to about the size of a baseball around a submerged stem or twig. Often the egg mass develops a green tinge due to algae growing in the jelly. The algae do not harm the developing eggs and their presence may represent a symbiotic relationship. The eggs receive oxygen produced as waste by the algae and the green-tinged egg mass blends in better with the surrounding vegetation. The algal cells, in return, receive waste carbon dioxide and nitrogenous compounds from the developing salamander embryos that they can use in their own metabolism. This symbiotic relationship of egg masses with algae is common among salamanders and some species of ranid frogs. The developing salamanders hatch in about a month. Empty jelly masses can often be seen floating in the pond until late in the summer. Unless neotenic, larvae will transform into terrestrial adults once they exceed about 85 mm in length. This usually occurs at 8 to 14 months of age, though some larvae take longer to reach transformation size, because of temperature, food availability and other environmental factors that affect their growth rate. After transformation, the salamanders take another year or more to reach sexual maturity.

Subspecies: There are two subspecies, both of which occur in British Columbia: the Brown Salamander (*Ambystoma gracile gracile*) on the south coast and Vancouver Island is replaced north of about Bella Coola by the British Columbia Salamander (*A.g. decorticatum*).

Range

Northwestern Salamanders are found along the Pacific coast west of the Coast and Cascade mountain ranges from southeast Alaska to northwestern California. In Canada, they are found all along the west coast of mainland British Columbia as well as on Vancouver Island.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Selected References: Eagleson 1976, Efford and Mathias 1969, Henderson 1973, Licht 1992, Walls et al. 1996.

Tiger Salamander *Ambystoma tigrinum*

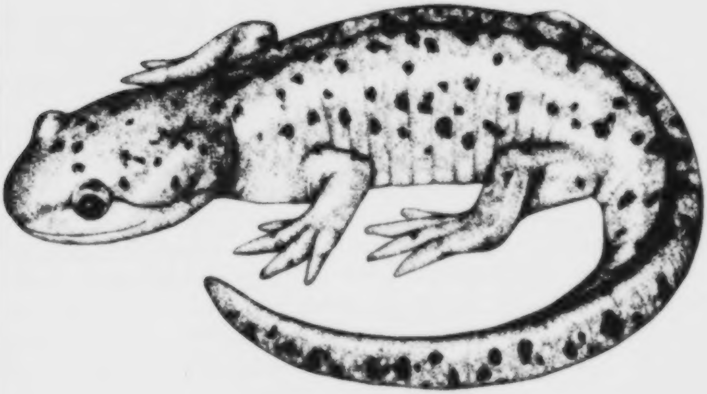
The Tiger Salamander is the largest terrestrial salamander in North America after the giant salamanders (*Dicamptodon* species) and the most widespread. It is one of the few salamanders capable of tolerating dry, desert-like conditions.

Description

Terrestrial adult Tiger Salamanders in British Columbia have large blotches of yellow, cream or dirty white on a black, grey or dark brown background. The borders of the blotches are often indistinct or they might join in such a way as to form a zebra-like pattern. Blotches can extend down the sides and do not form a distinct dorsal stripe. The colour patterns vary: some individuals are predominantly yellowish with irregular black striping, while others are mainly black with scattered yellowish blotches. Juvenile transformed Tiger Salamanders can be irregularly mottled and spotted without discernible blotches. The belly is dirty grey; the legs and tail are mottled with light and dark patches. The rounded head is at least as wide as the body, but is relatively short. The small eyes are widely spaced on the sides of the head. This salamander usually has 13 costal grooves on each side of its body. The well-developed legs overlap by 3 or 4 costal grooves when adpressed. Each foot has two tubercles on the sole. Males have a slightly longer tail than females and have a swollen vent during the breeding season. An adult terrestrial Tiger Salamander can grow to 327 mm long, but most reach between 140 and 180 mm; the tail makes up about half of the total length. See colour photograph 7.

Tiger Salamander larvae live in ponds. They have large, feathery gills that are longer than the head. The head is depressed and the eyes are small for the size of the head. Unlike larvae of other ambystomatid salamanders in British Columbia, young Tiger Salamander larvae do not have balancers behind the head as they are resorbed just prior to hatching. The larvae can reach up to 80 mm in length before transforming. Neotenic individuals occur in some permanent water bodies and can grow to about 330 mm long. See colour photograph 10.

Distinguishing Features: The large, heavy body that appears to be smeared with yellow, grey or black so that it is covered with irregular blotches, vertical stripes and spots. A wide, rounded head



with no parotoid glands. Two tubercles on the sole of each foot. Prominent costal grooves. Pond-dwelling larvae have large, feathery gills (see page 28).

Habits

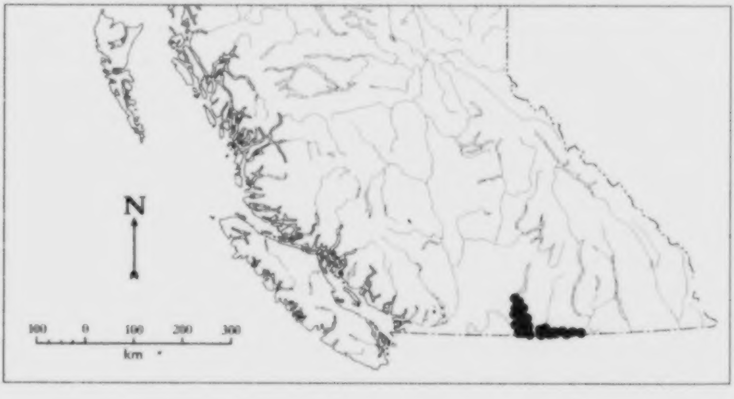
Tiger Salamanders inhabit the dry, southern interior of the province, commonly associated with Ponderosa Pine (*Pinus ponderosa*), Bluebunch Wheatgrass (*Agropyron spicatum*) and Interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*). Terrestrial adults are usually found near small lakes and ponds, but are rarely seen outside the breeding season. They can resist periods of drought due to their subterranean habits. During the summer they hide below ground in abandoned small mammal burrows or other hollows, although they are capable of excavating their own burrows. They are active on the surface only at night, usually during or just after spring or fall rains. Tiger Salamanders eat earthworms, insects, molluscs and other invertebrates, as well as the occasional frog, toad or baby mouse. When threatened, they sometimes arch their long tail into the air menacingly. Tiger Salamanders are likely eaten by snakes, Coyotes (*Canis latrans*) and large birds such as Great Blue Herons (*Ardea herodias*).

Neotenic adult Tiger Salamanders live in deep, permanent pools or small lakes and seem to be tolerant of non-vegetated, alkaline or nutrient-laden water bodies. They eat small fishes, aquatic insects, worms and the larvae of their own species, but easily fall prey to large predatory fishes. While pond drying is catastrophic to the neotenic adults, it also eliminates fish, allowing terrestrial Tiger Salamanders to recolonize the habitat if they are still around.

Breeding

From March to May, transformed adult Tiger Salamanders migrate to nearby permanent or semi-permanent lakes and ponds to breed. They can travel up to seven kilometres to a mating place. These salamanders do not engage in amplexus. Courtship consists of nudging, pushing and the lashing of tails. Finally, the male crawls ahead of the female and, lifting his tail, lays a spermatophore for the female to pick up. Males compete vigorously for mates. They try to push and shove their chosen ones to more secluded spots, but other hopeful males often interfere. Males also tend to deposit their spermatophores on top of other spermatophores to cover them. A male can produce many spermatophores during courtship season.

A female lays her eggs shortly after mating, either singly or in small masses, attaching them to submerged vegetation, stones or twigs in shallow water. She can lay up to 5000 eggs, although usually in small clusters. The eggs hatch in two to three weeks and the rapid-growing larvae transform (unless neotenic) within three to four months or during the second summer. Most larvae prefer warm areas of the pond where there is abundant food and considerable growth of algae to hide in. They eat nematodes, ostracods and copepods when they are small, but as they grow larger, graduate to insects, crayfish, snails and their siblings. Although not recorded in British Columbia, Tiger Salamander larvae in many



other places become preferentially cannibalistic and develop characteristically large heads, slit-like eyes and fang-like teeth. Tiger Salamanders usually reach sexual maturity in their first year, whether terrestrial or neotenic. They can live up to 25 years.

Subspecies: The Tiger Salamander is highly variable in colour and pattern across its range in North America. As many as seven subspecies have been recognized by some authorities, but only the Blotched Tiger Salamander (*Ambystoma tigrinum melanostictum*) occurs in British Columbia.

Range

Tiger Salamanders are found across the United States, except the Appalachians, north into Alberta and British Columbia, and south through eastern Mexico. In British Columbia, they inhabit the Okanagan Valley as far north as Peachland, west to Keremeos and east to Christina Lake.

Selected References: Anderson 1971, Collins 1981, Hoffman and Pfennig 1999, Semlitsch 1983, Sexton and Bizer 1978.

FAMILY PLETHODONTIDAE
LUNGLESS SALAMANDERS

Western Red-backed Salamander
Plethodon vehiculum

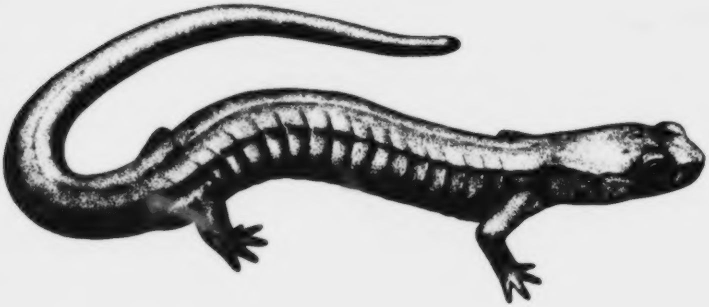
Other Names: Redback Salamander.

All members of the large family of plethodontid salamanders breathe air as adults, but none have lungs; thus they are known as lungless salamanders. Instead, they breathe through the skin and the lining of the mouth. As with other air-breathing salamanders, a lungless salamander will pump its throat up and down to push air in and out of the mouth cavity, but there is no visible movement of the salamander's sides because there are no lungs inside to inflate and deflate. Members of this family tend to live long, often for more than 10 years.

Description

Most Western Red-backed Salamanders have an unbroken, broad red-orange stripe extending along the back from the snout to the tip of the tail, although colouration of the stripe can vary from yellow-green to tan or brown; and some individuals, particularly those in coastal areas, lack the stripe and appear entirely black, a condition known as melanism. All of these colour variations can occur in the same area. The sides and belly are dark bluish grey with spots and flecks of white or yellow.

The Western Red-backed Salamander is slender and short-legged. When disturbed, it tends to squirm quickly from side to side rather than run away. It has 14 to 18 costal grooves (usually 15 or 16) on each side of the body. The tail is about the same diameter as the body for most of its length. The head is long and parallel-sided with a rounded snout (more squared in males, but hard to distinguish). The eyes are well forward on the head. There is a prominent gular fold under the neck. Adpressed limbs have 3 to 6 costal grooves between them. For the most part, males and females look similar. This salamander can range from 80 to 115 mm long, with the tail making up half its length. This species has no free-living larval stage. See colour photograph 11.

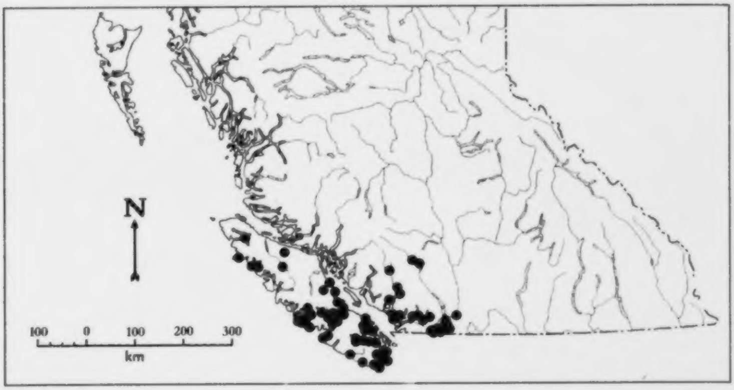


Distinguishing Features: Slender body usually with an unbroken, smooth-edged, bright red or orange stripe along the back and tail. The short legs, when adpressed, do not meet. Nasolabial grooves are difficult to see without the aid of a magnifying glass.

Habits

Western Red-backed Salamanders are entirely terrestrial. They can generally be found in damp leaf litter and forest debris of mature and old-growth forests, and under moss, rocks and decomposing logs, which seems to be their preferred habitat. They do not fare well in clear-cuts or open sunny areas, because they require moisture to enable them to breathe through the skin. Like all lungless salamanders, the Western Red-backed Salamander must keep its skin moist and in contact with the air for oxygen and carbon dioxide exchange to occur via diffusion. But this salamander does better in younger reforested stands than do most other species of salamanders.

Although they have little need for streams or ponds, Western Red-backed Salamanders can be found in riparian areas associated with water sources. But they can drown even in shallow water if they cannot crawl out of it. They feed on a wide variety of terrestrial invertebrates, including springtails, mites, spiders, isopods and other ground-dwelling arthropods. Western Red-backed Salamanders are not known to be territorial, unlike many species of *Plethodon* including the very similar looking Eastern Red-backed Salamander (*P. cinereus*), which does not occur anywhere near British Columbia. They can, however, detect each other's presence by smell and maintain small, non-exclusive home ranges of no more than a few square metres.



Breeding

Breeding activity begins in the late summer, but takes place mostly in the fall. During courtship, the male nudges or rubs the female with his chin, then the pair engages in a tail-straddling walk, in which the female rests her head on the male's lower back and follows along behind him while walking on either side of his tail. While in this position, the male deposits his spermatophore on the ground and leads the female to pick it up. A courting male lays only one spermatophore. The female stores the sperm internally in a spermatheca until she lays her eggs in the spring. Courtship and mating occur entirely on land.

The female finds a hollow underground or in damp wood to lay 8 to 20 (usually 10) round, unpigmented eggs. She stays with her eggs until they hatch. Such brooding behaviour is common among terrestrial plethodontid salamanders and helps to prevent eggs from drying out or being attacked by fungus. The larval salamanders develop within their eggs and hatch in an advanced state, often in late summer or early fall. The gills and yolk supply that sustained the larva inside the egg do not persist long after hatching. The young emerge from the nest with the onset of autumn rains, when they are 25 to 30 mm long; they mature in about two years. Although males can produce sperm every year, females only lay eggs every second year.

Subspecies: None.

Range

Western Red-backed Salamanders are usually found along the western side of the Coast and Cascade mountain ranges from southwestern British Columbia to southwestern California. In British Columbia, they occur throughout Vancouver Island, on the adjacent mainland, through the Fraser River valley to Hope, and up the Lillooet River to Pemberton.

Selected References: Dupuis et al. 1995, Dupuis and Bunnell 1999, Feder 1983, Ovaska 1987, Ovaska and Gregory 1989.

Coeur d'Alène Salamander
Plethodon idahoensis

The Coeur d'Alène Salamander was not discovered in British Columbia until 1981 and is the only lungless salamander found in the eastern part of the province.

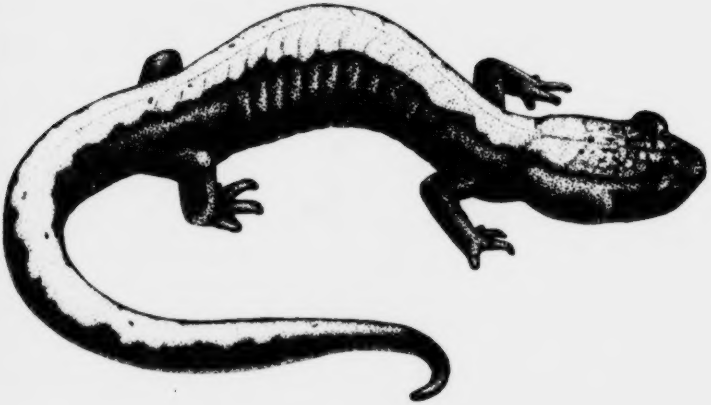
Description

The Coeur d'Alène Salamander is black with flecks of white or yellow, and a yellowish throat. A yellow, orange or red stripe with an uneven edge extends along the back from the snout to the tip of the tail; the stripe is solid, except on top of the head where it usually breaks up into patches. It has large, well-developed parotoid glands at the back of the head, nasiolabial grooves, and 14 costal grooves on each side of the body. The tail is about the same diameter as the body for most of its length. The head is long and parallel-sided with a rounded snout and the eyes are placed well-forward on the head. The neck has a prominent gular fold, and the throat is yellowish. The feet have short, slightly webbed toes. One to three costal grooves show between adpressed limbs. Males and females appear similar, though the females are slightly larger. This salamander can grow to 120 mm long, half its length being the tail. It has no free-living larval stage. See colour photograph 12.

Distinguishing Features: The uneven-edged yellow-to-red stripe running from the tail, along the back to the head where it breaks into patches. Nasolabial grooves and yellowish throat. The short, slightly webbed toes. Not as slender as the Western Red-backed Salamander and its legs are longer.

Habits

Coeur d'Alène Salamanders live in wet, well-shaded, rocky seepages or stream banks in coniferous forests. They require cool, damp places, because like other lungless salamanders, they rely on their moist skin for respiration. They generally live among loose or fissured rock near or beside streams and waterfalls and sometimes venture into wet caves or abandoned mine shafts. Coeur d'Alène Salamanders usually come to the surface only on moist nights in spring and fall. They eat mostly aquatic and semi-aquatic insects, especially adult and larval flies.



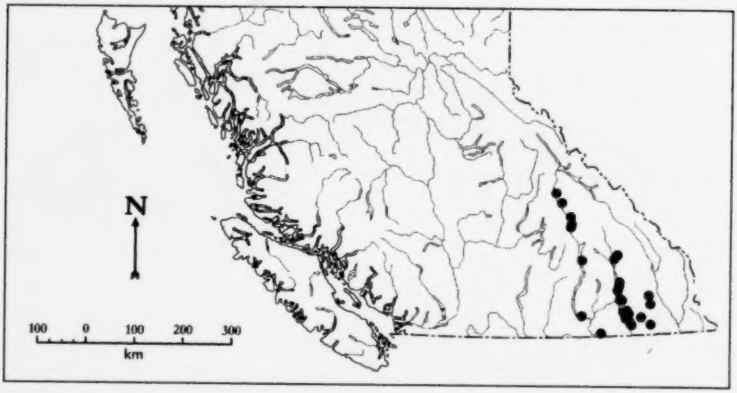
Breeding

Courtship can occur in early spring or fall. The male and female engage in tail-straddling that can last over an hour, the female resting her head on the male's lower back and following along behind him while walking on either side of his tail. While they are in this position, the male deposits a spermatophore on the ground and the female follows to pick it up. The female stores the sperm internally in a spermatheca for up to nine months before she lays 4 to 12 white, yolky eggs under a rock or deep in a rocky underground crevice. She stays with her eggs until they hatch, as is common among terrestrial plethodontid salamanders. The larval salamanders develop within their eggs and hatch looking like miniature adults, just 35 mm long. They mature in three to five years. The females seem to breed every second year.

Subspecies: None.

Range

Coeur d'Alène Salamanders are found in northern Idaho and extreme western Montana north into adjacent southern British Columbia. In this province they occur in the narrow region between Kootenay Lake and the Purcell and Moyie mountain ranges, up the Columbia River valley, around Revelstoke, and almost as far north as Mica Creek.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Selected References: Brodie and Storm 1970, Groves et al. 1996, Ministry of Environment 1998a, Wilson and Larsen 1998, Wilson et al. 1989, 1997.

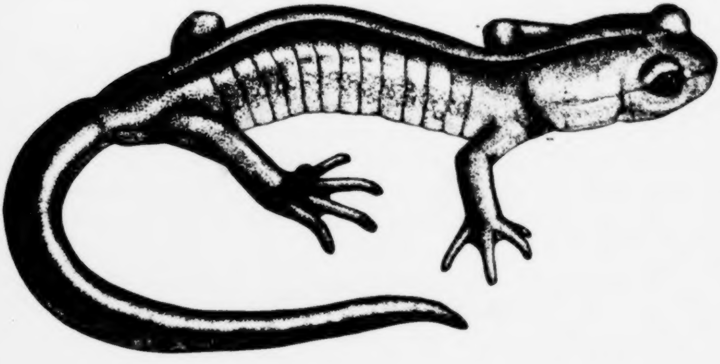
Ensatina *Ensatina eschscholtzii*

Other Names: Red Salamander, Oregon Ensatina.

The Ensatina comes in many colour variations throughout its range from Baja California to southwestern British Columbia. Only one subspecies occurs here, but the subspecies in California can range from black with orange limbs to brown mottled with yellow and black to solid brown. Different forms have either yellow or brown eyes. Most of the seven recognized subspecies can interbreed, but others cannot or do so only rarely. Some scientists argue there are actually several species.

Description

In British Columbia, the Ensatina is evenly medium brown to pinkish tan, with no distinctive spots, stripes or blotches, although the sides can have yellow or brown flecks. The bases of the limbs and feet can appear yellowish. The pinkish belly is almost transparent and often covered with scattered dark speckles, whereas the head, back and sides are covered with silver-white flecks. The hooded brown eyes are large and prominent. The snout is rounded. Easily discernible nasolabial grooves run down from each nostril to the mouth. The gular fold is well developed. Each side of the body has 12 costal grooves. The spindly legs, when adpressed, meet or overlap by up to 3 costal grooves. The tail is rounded in cross-section and has a definite constriction near the base; females tend to have a much more discernible constriction due to a relatively fatter tail. A



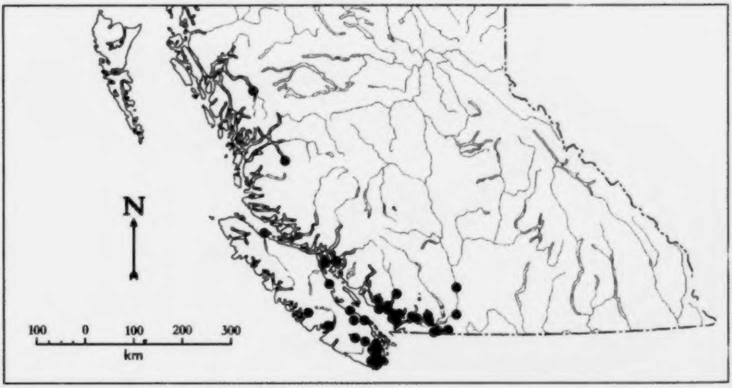
glandular ridge runs along the top of the tail. Males have slightly longer, narrower tails than females, although females grow longer in overall body length. Ensatinas can be 70 to 120 mm long, about half of which is tail. Hatchlings are dark purple with light flecking. Slightly larger juveniles resemble adults but tend to have more light and dark flecking on the sides. Ensatinas have no free-living larvae. See colour photographs 13 and 14.

Distinguishing Features: The uniform brown to pinkish colour. The constriction at the base of the tail. Nasolabial grooves, but no parotoid glands.

Habits

Ensatinas are entirely terrestrial and never enter standing water. They can be found in slightly drier habitats than other salamanders, from clear-cuts to old growth forests, preferring habitats with considerable leaf litter and debris for cover. During damp weather Ensatinas can be found under rocks, boards or logs, but they will retreat into moist crannies in logs or between rocks when conditions are drier. Like most salamanders, they are usually nocturnal. There is some evidence that Ensatinas are territorial outside the breeding season and mark their territories with fecal pellets.

When disturbed or startled, an Ensatina rises up stiffly on all four legs and waves its tail in the air. The glands on the dorsal side of the tail secrete a white, noxious poison for defence. When threatened by a predator, the Ensatina can deliberately break off its tail at its basal constriction. The predator that grabs the tail will be left with a writhing, foul-tasting tail, but no salamander. Eventually,



the Ensatina will grow a new tail, though it will be smaller. This salamander's diet includes worms, spiders, springtails, mites and other small arthropods. It catches food by flicking out its sticky mushroom-shaped tongue, which is attached to the floor of its mouth by a stalk.

Breeding

Mating seems to occur in the fall and spring. Like the closely related Western Red-backed Salamander, Ensatinas engage in an elaborate courtship procedure where the male slowly approaches the female and rubs her head and throat with his head. He then manoeuvres in front of her and leads her in a tail-straddling walk that can last for many hours. During this promenade, the female rests her chin on her mate's lower back. At length the male stops and, rocking his hips back and forth, deposits a spermatophore on the ground. He leads the female forward so that she can pick it up with her cloaca as he caresses her with his tail.

Developing eggs within a female are readily visible through the translucent body cavity. In late spring, the female lays a cluster of about 8 to 10 colourless eggs in an underground chamber or rotted log. Nests are well hidden and rarely found. She broods them all summer until they hatch three to five months later, in the fall. The young salamanders hatch fully developed, having gone through all the developmental stages within the egg; they reach sexual maturity at about three to four years. Females do not breed every year. Ensatinas live about 15 years in the wild.

Subspecies: Many subspecies have been described, but only the Oregon Ensatina (*Ensatina eschscholtzii oregonensis*) occurs in British Columbia.

Range

Ensatinas range from southwestern British Columbia to Baja California. In Canada, they occur only in British Columbia, west of the Coast and Cascade mountain ranges, in the southern and eastern regions of Vancouver Island north to Port McNeill, on the adjacent mainland coast north to Kitlope, and up the Fraser River valley as far as Boston Bar.

Selected References: Beneski 1989, Carl 1940, Deban 1997, Norman 1986, Stebbins 1954, Wake and Schneider 1998.

Wandering Salamander *Aneides vagrans*

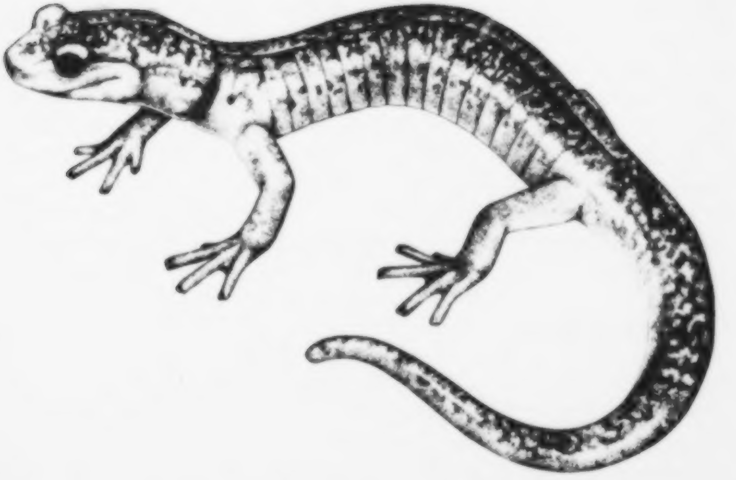
Until 1998, members of this species in British Columbia were known as the Clouded Salamander (*Aneides ferreus*). Then, genetic evidence revealed that populations on Vancouver Island and several nearby islands, as well as in northern California, belonged to a species distinct from Clouded Salamander populations in Oregon and northernmost California. References to the Clouded Salamander in British Columbia published prior to 1998 actually refer to what we now know as the Wandering Salamander.

Description

The Wandering Salamander is dark brown to greyish black with numerous light grey or bronze-gold blotches, mottling or speckles covering the head, back and tail. Juveniles have a bronze dorsal stripe and a patch on the head and snout that disappear with age. The belly is grey with yellowish flecks. The head is large and somewhat triangular, due to the large jaw muscles. The eyes are large, bright and protuberant. As in all lungless salamanders, a nasolabial groove runs down from each nostril, but it can be difficult to see. The upper teeth project over the lower jaw and can be felt by running a finger under the snout. The line of the mouth bends up and then down again as it runs along the side of the face, giving the salamander a sort of insipid, bucktoothed smile. It has a prominent gular fold and 15 costal grooves on each side of the body. The legs are long and the toes are distinctly squared at the tips. While the innermost toe of each foot is small, the others are relatively long, with the outer toe of the hind foot about as long as the toe beside it. The hind feet are as wide as they are long. When the legs are adpressed, the digits of the front and back feet usually touch and often overlap. The tail is circular in cross section, strongly tapered, possibly prehensile and rarely broken.

Wandering Salamanders grow up to 133 mm long. The males and females are similar in appearance. This species has no free-living larva. See colour photograph 9.

Distinguishing Features: The brown to black colour, with diffused light grey or bronze-gold mottling or speckles, but no dorsal stripe. Nasolabial grooves. Squared-off toes. No constriction at the base of the tail.



Habits

The Wandering Salamander inhabits low elevation,.coastal Douglas-fir (*Pseudotsuga menziesii*) and Western Hemlock (*Tsuga heterophylla*) forest stands of various ages. They are entirely terrestrial and usually found in rotting logs or underneath loose bark or moss covering dead trees or stumps. It is an active and agile salamander that can climb trees to considerable heights. If grabbed by a predator, glands along its tail secrete a foul-tasting irritant. Like other plethodontids, these salamanders are usually nocturnal and most active during wet weather. They eat ants, springtails, mites and other ground-dwelling arthropods.

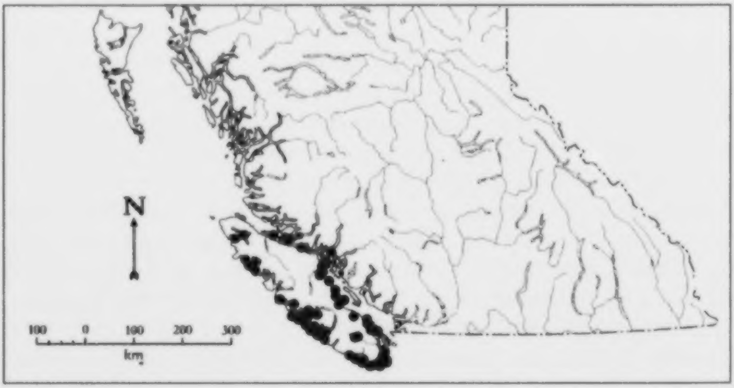
Breeding

Courtship and mating takes place in spring and possibly in the fall. The courtship is pursued on land and follows a pattern similar to that of other terrestrial plethodontid salamanders (see those accounts). Females lay their eggs in late spring or early summer in a cavity under bark or inside a log. Douglas-fir trees and logs seem to be favoured as nesting sites. The eggs are colourless and dangle individually from the roof of the nest at the ends of long, entwined stalks, like a cluster of grapes. Clusters range from 5 to 25 eggs. An attending parent, likely the mother, stays with the eggs until they hatch in the fall and does not eat during this period. Due to the amount of energy reserves needed to build up for breeding, females do not breed every year. The brooding parent eats any dead or infected eggs, which likely helps prevent fungus or disease from spreading throughout the clutch. The young go through their entire development inside the egg in about three months and hatch ready to fend for themselves on land. Embryonic salamanders develop long, branching gills that press close to the egg membrane and enable them to respire through the egg capsule. They resorb the gills just before hatching. Wandering Salamanders take at least three years to mature.

Subspecies: None.

Range

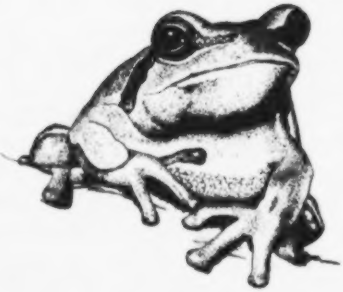
Wandering Salamanders are found in two, completely separated regions: northern California, and British Columbia on Vancouver Island and several of its smaller, surrounding islands. It does not occur in Washington, Oregon and northernmost California. There is a recent report of Wandering Salamanders at a site on the British Columbia mainland near Trout Lake north of Sechelt. Previous reports from the mainland are unconfirmed and likely misidentified individuals of other species. The severely disjunct distribution of the species remains a mystery. One theory is that Wandering Salamanders were accidentally introduced to Vancouver Island in the 19th century, coming from northern California in shipments of oak bark imported by tanneries in southern British Columbia; they spread quickly throughout the island and rafted to surrounding



islands on loose logs. Tantalizing as this idea may be, it demands an improbably rapid range expansion on Vancouver Island as well as overseas dispersal to small islands and perhaps the mainland. It may be, instead, that the range of this salamander was fragmented during the Pleistocene glaciation thousands of years ago, with one part finding refuge on and around Vancouver Island.

Selected References: Davis and Gregory 1993, Guppy 1953, Harestad and Stelmock 1983, Jackman 1998, Ryder and Campbell 2004, Stelmock and Harestad 1979.

Frogs and Toads



Over 5000 species of frogs and toads in 29 families make up the order Anura. Collectively, they can all be referred to as "frogs". All of them share physical traits associated with jumping or hopping: enlarged, muscular hind legs and an elongated pelvis that enables the legs to propel the body upward and forward. All frogs have lost their tails – even the tailed frogs (see page 110). Their skeletons are smaller and lighter than other vertebrates of their size. Most frogs have eight or fewer presacral vertebrae and no ribs; in this regard, tailed frogs are considered primitive because they have nine presacral vertebrae, free ribs and tail-wagging muscles. All frogs have fewer skull bones than most vertebrates, and in each forearm and calf the bones are fused into a single element. Frogs also have fewer teeth than other vertebrates, and no teeth on the palate, as there are in salamanders. Most frogs have teeth only on the upper jaw, and some, like the toads of the genus *Bufo*, have none at all. All of the structural characteristics of frogs make them easy to recognize, yet they show astounding variation.

Frogs vary in shape. The globular rain frogs of the genus *Breviceps* of southern Africa have legs so short that the male cannot clasp the female when mating and instead glues himself to her back to hold on. The long-legged, gangly treefrogs of the genus *Phyllomedusa* of South America climb through the trees by grasping branches with opposable thumbs and toes. The Mexican Burrowing Toad (*Rhinophrynus dorsalis*), has a tiny mouth and feeds mainly on termites, whereas the many species of horned frogs (*Ceratophrys* species) of South America have a huge head and mouth and will eat other frogs, as well as small mammals. Horned frogs are belligerent and will try to bite their enemies, in marked contrast to the timidity of most frogs. The Goliath Frog (*Conraua goliath*) of Cameroon and Equatorial Guinea can be over 30 cm long, whereas the smallest frogs – *Sminthillus* of Cuba, *Inseutophryne* of Brazil and *Sooglossus* of the Seychelles Islands – measure no more than a centimetre long when fully grown.

Some frogs are experts at camouflage: *Megophrys* from southeast Asia looks identical to dead leaves. Others have dazzling colours: the dart-poison frogs (family Dendrobatidae) of Central America and South America can be bright red, gold, purple, black, blue, green or any combination of these colours; the Golden Mantella (*Mantella aurata*) of Madagascar is glowing orange with black eyes; and the Coroboree Toadlet (*Pseudophryne corroboree*) from Australia has vibrant yellow and black markings. Whereas most frogs have large, bright eyes, the burrowing Turtle Frog (*Myobatrachus goeldi*) of the Australian outback has tiny eyes half hidden on top of its head.

The differences between a frog and a toad are frequently subjective. The term "frog" should, by rights, apply only to the frogs of the genus *Rana* whereas "toad" should be reserved for toads of the genus *Bufo*. These are the genera native to England and originally given these English names. In essence, a frog is adapted for living in or near water: it has a smooth skin and a streamlined shape that enables it to move easily through water, and its long hind legs have fully webbed feet and are designed for swimming. Toads, on the other hand, are adapted for life away from water, with thicker, warty skin, a squat body and short legs that are better suited for short hops or crawling over land. Frogs are better swimmers than toads, but toads are better burrowers than frogs. Only a few of the world's frogs and toads belong to the genera *Rana* and *Bufo*. The rest are assigned "frog" or "toad" largely depending on whether they appear to be more frog-like or more toad-like. Among the members of the order Anura, there are frogs more aquatic than *Rana* that never leave the water, and toads more terrestrial than *Bufo* that never need to visit a pond or stream, and there are midwife toads, chorus frogs, narrowmouth toads, clawed frogs, fire-bellied toads and dart-poison frogs, none of which are closely related to ranid frogs, bufonid toads or to each other. No wonder scientists use their Latin names.

Selected References: Duellman and Trueb 1994, Phillips 1994, Stebbins and Cohen 1995, Vial 1973, Wright and Wright 1995.

Key to the Adult Frogs and Toads of British Columbia

1a. Pupil of eye vertical when contracted .2
1b. Pupil of eye horizontal when contracted 4

2a. Sharp-edged, horny spade on underside of foot; body squat and toad-like . .Great Basin Spadefoot Toad *(Spea intermontana)*
2b. No spade on foot; male has tail-like copulatory organ 3

3a. Fine black speckles on dorsal and ventral surfaces; found in extreme southeastern British Columbia only . . . . .Rocky Mountain Tailed Frog (*Ascaphus montanus)*
3b. No black speckles on dorsal and ventral surfaces; found in the Coast Mountains . . . . .Coastal Tailed Frog (*Ascaphus truei)*

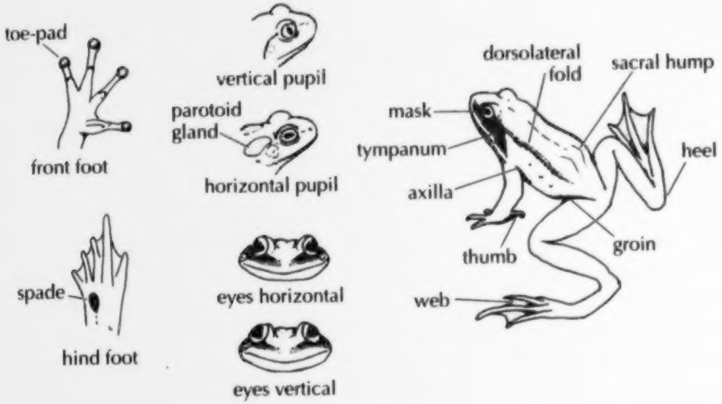
4a. Parotoid glands and rough warts on skin; body squat . . . . .Western Toad (*Bufo boreas)*
4b. No parotoid glands or warts; skin smooth or with scattered tubercles 5

5a. Adhesive toepads conspicuous; dark eye stripe ending at shoulder .Pacific Treefrog (*Hyla regilla)*
5b. Toepads absent or inconspicuous 6

6a. Body elongated, with dark side stripes extending to groin and three dorsal stripes or series of spots . . . . .Boreal Chorus Frog (*Pseudacris maculata)*
6b. No side or dorsal stripes; has dorsolateral folds or skin fold around ear membrane 7

7a. Large, rounded spots with light halos on a green or brown back; belly white; dorsolateral folds present .Northern Leopard Frog (*Rana pipiens)*
7b. No large, rounded spots on back 8

8a. Green or olive-green, with no dark facial mask; males have deep yellow throat and ear membranes larger than the diameter of the eye 9
8b. Brown or tan, possibly with black irregular spots on back; obvious dark facial mask 10


toe-pad
front foot
vertical pupil
parotoid gland
horizontal pupil
spade
hind foot
eyes horizontal
eyes vertical
dorsolateral fold
sacral hump
mask
tympanum
axilla
heel
thumb
groin
web

9a. Dorsolateral folds present .. ....Green Frog (*Rana clamitans*)
9b. Dorsolateral folds absent, skin fold around ear membrane present ....Bullfrog (*Rana catesbeiana*)

10a. Distinct black facial mask; no black dorsal spots; white belly; possible white mid-dorsal stripe ..Wood Frog (*Rana sylvatica*)
10b. Red, orange or yellow underneath, especially in older individuals; dark spots on back; facial mask not intensely dark 11

11a. Eye not upturned; red underparts; bones of lower leg may be visible through skin; area of green in groin ....Red-legged Frog (*Rana aurora*)
11b. Eye upturned; salmon colour on white background on belly and under legs; distinct dark spots on back; no green area in groin 12
12a. Inconspicuous grey mottling on belly; found only in British Columbia's lower Fraser River valley ....Oregon Spotted Frog (*Rana pretiosa*)
12b. No grey mottling on belly; in British Columbia found everywhere except lower Fraser River valley ....Columbia Spotted Frog (*Rana luteiventris*)

FAMILY ASCAPHIDAE

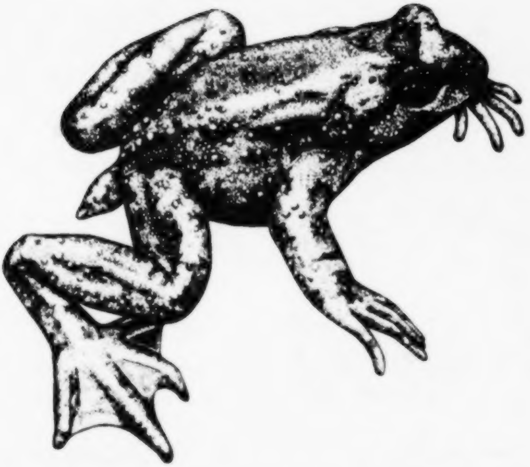
Coastal Tailed Frog *Ascaphus truei*

Other Names: Tailed Toad, Bell Toad.

The two species of tailed frogs are the only members of the family Ascaphidae and are remarkably different from other frogs. All frogs and toads characteristically lose their ribs and tails when they leave the tadpole stage, but adult tailed frogs retain free ribs and vestigial tail-wagging muscles. The tail-wagging muscles have nothing to do with the male's false tail, though, which is used in mating. Tailed frogs are the only frogs in North America to fertilize their eggs internally. The tongue of tailed frogs attaches to the back of the mouth, rather than the front as in most other frogs and toads, so it cannot be flipped out rapidly but merely protruded to catch insects. Only recently has genetic evidence revealed that the Coastal Tailed Frog and the Rocky Mountain Tailed Frog, which are virtually identical in appearance, are sufficiently distinct from each other to be recognized as different species. Any reference to the Tailed Frog (*Ascaphus truei*) published before 2001 and referring to populations in the Coast and Cascade mountains is about the Coastal Tailed Frog (*A. truei*) and not the Rocky Mountain Tailed Frog (*A. montanus*).

Description

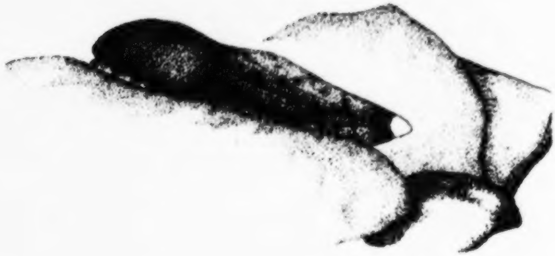
This delicate-looking frog is usually brown or grey, although some are pinkish or even black. It has a light patch between the eyes that extends forward across the snout, and no spots or blotches on the back. The belly is usually translucent pink. Small white dots are scattered over the belly and sides. Copper markings on transformed individuals may have orange undertones, rather than green as in Rocky Mountain Tailed Frogs. The head of the Coastal Tailed Frog is wide and the nostrils far apart. The eyes have vertical, diamond-shaped pupils. A slight fold of skin curves back from the eye to the corner of the mouth. The tympanum is not visible. This frog has no dorsolateral folds or glandular warts, although it may have small tubercles. The hind feet are almost fully webbed, though the toes are short. The outermost hind toe is thicker than the rest.



Adult male Coastal Tailed Frogs are 30 to 40 mm long and have a fleshy "tail", which is actually an extension of the cloaca. In the breeding season, males develop black pads on the hands and black tubercles on their arms and sides. Females are slightly larger than males and can reach 50 mm in length. See colour photograph 23.

The tadpoles of tailed frogs are unusual. They have large, suctorial mouth parts under the head. The mouth disc has broad, horny upper jaws and many labial teeth. It provides great suction, enabling the tadpole to adhere to rocks in streams with fast currents so that it is not washed downstream. While holding on, the tadpole feeds on algae that it scrapes off the rocks with its rows of small teeth. Tadpoles of the Coastal Tailed Frog vary from dark green to black, but are typically slate grey, up to 30 mm long, and often have a white spot on the tip of the tail. See the illustration on the next page and colour photograph 21.

Distinguishing Features: Both species of tailed frogs have vertical pupils and do not have spades or horny tubercles on the soles of the feet. Their outer hind toes are rounded and thicker than the rest. The head is wide for a frog and the tympanum is not visible. Males have an unmistakable tail-like extension of the cloaca. Coastal Tailed Frogs lack the fine, black speckles of Rocky Mountain Tailed Frogs and have slightly less extensively webbed hind feet.



Habits

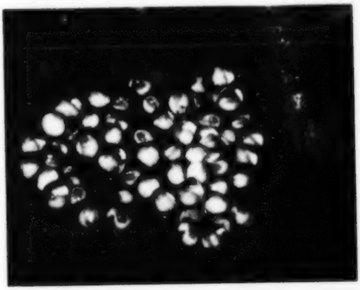
Coastal Tailed Frogs inhabit cold, clear, unsilted streams measuring half a metre to 15 metres wide from sea level to as high as subalpine meadows. They tend to avoid very steep streams in which rocks and debris frequently slide down and which are subject to high seasonal run-off. They also avoid slow-moving streams in flat areas, which are often warmer and accumulate silt and filamentous algae. Tailed frogs have small lungs and rely on their vascularized skins for much of their respiratory gas exchange. Small lungs do not present a problem to a frog that lives in a fast-flowing, well-oxygenated stream; they also make the frog less buoyant, helping it stay under water.

Coastal Tailed Frogs are usually associated with mature and second-growth forests, but populations do survive in streams following logging activity. Tadpole densities have been found to be higher in streams in some clearcuts than in streams surrounded by mature forests, possibly because opening the forest canopy allows extra sunlight to reach the stream, increasing the growth of algae that the tadpoles graze on. But if the stream becomes excessively silted, the algae and tadpoles may not survive. Lack of a forest canopy in a clearcut also increases the terrestrial adults' exposure to predators and the risk of desiccation from sunlight and wind. Thus, the habitat surrounding a stream that is suitable for algae-feeding tadpoles may not be suitable for the metamorphosed frogs emerging onto land.

During the day, Coastal Tailed Frogs tend to hide under rocks or logs along or in a stream or in nearby rivulets. They are most active at night, when they sometimes wander into the forest to forage for food. Coastal Tailed Frogs eat terrestrial and aquatic insects. While their cryptic colouration allows them to blend in well with their surroundings, they face predatory threats from snakes, fishes, larger frogs, birds, predatory invertebrates, small mammals, and where their ranges overlap, Coastal Giant Salamanders.

Breeding

Coastal Tailed Frogs tend to breed in the fall. They are not known to vocalize and it is not known how mates find each other. During mating, the male clasps the female around the waist in pelvic amplexus for 24 to 30 hours and uses the tail-like extension of the cloaca for insemination. The sperm remain viable within the female's oviduct until egg-laying many months later.



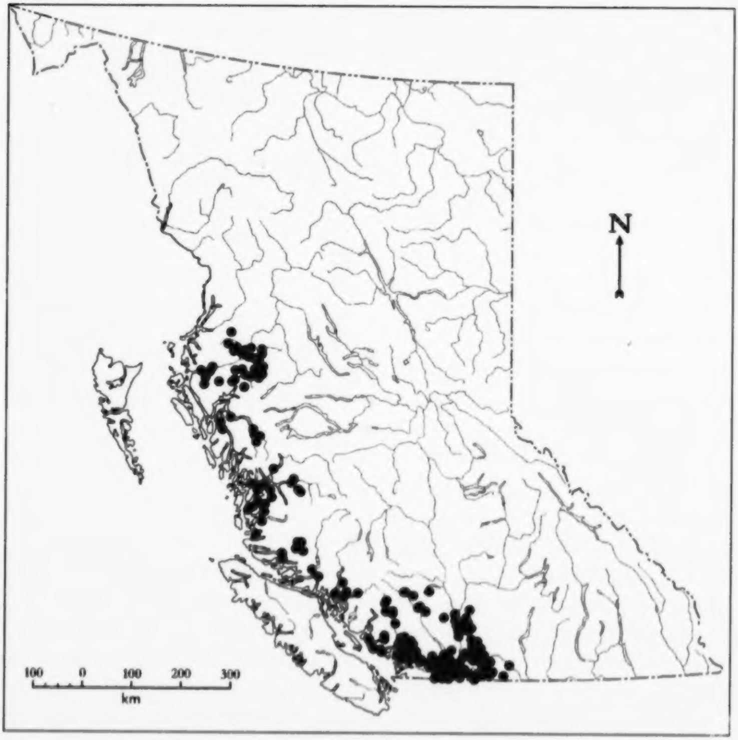
Collected eggs of a Coastal Tailed Frog. DANNY KENT.

In midsummer the female will lay 35 to 100 (usually 45 to 75) clear, unpigmented eggs in small clusters, fixing them to the undersides of rocks in streams. Tadpoles move slowly over the rocks, using their sucking mouthparts to hang on and scrape off algae and diatoms as they go. They can swim in short bursts, even upstream. Small tadpoles tend to be found in pools in the stream, but larger tadpoles will inhabit riffles. Sometimes they can be seen clambering over exposed rocks in midstream. Tadpoles metamorphose at one to three years of age, usually in early spring or late summer; see colour photograph 22. Transformed frogs reach sexual maturity in three to five years. Tailed frogs are estimated to live 15 to 20 years, making them the longest-lived frog in North America.

Subspecies: None.

Range

The Coastal Tailed Frog occurs along the mainland coast of British Columbia as far north as the Nass River (just south of the Alaskan panhandle) and east to Terrace. In southern British Columbia, it occurs up the Fraser River valley to Lytton and east to the Cathedral Lakes. It is not recorded on Vancouver Island, in Alaska or in the Yukon. In the United States it ranges along the Cascade Mountains from the Canadian border to northwestern California.



Selected References: Brown 1975, Bull and Carter 1996, Bury and Adams 1999, Dupuis 1998, Dupuis and Steventon 1999, Matsuda 2001, Neilsen et al. 2001, Ritland et al. 2000.

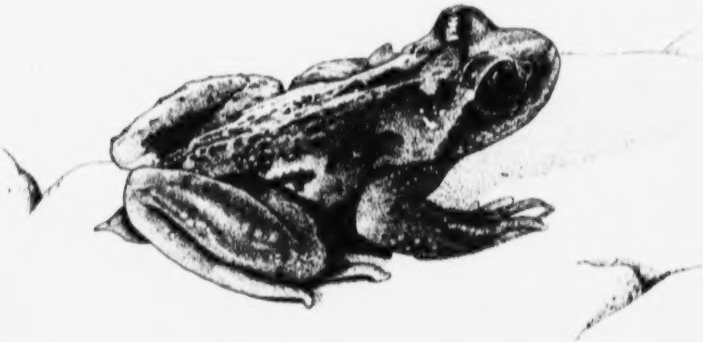
Rocky Mountain Tailed Frog
Ascaphus montanus

Other Names: Tailed Toad, Bell Toad.

Any reference to the Tailed Frog (*Ascaphus truei*) published before 2001 and referring to populations east of the Cascade Mountains (i.e., in British Columbia's south Kootenay region) is about the Rocky Mountain Tailed Frog (*A. montanus*).

Description

The Rocky Mountain Tailed Frog is a delicate-looking frog that is usually brown or grey, although some are pinkish or even black. The head is wide and the nostrils far apart. It has a light patch between the eyes that extends forward across the snout, and no spots or blotches on the back. The belly is usually translucent pink. Unlike the Coastal Tailed Frog, it has distinct, dense, fine black speckling on its dorsal and ventral surfaces, and the copper markings on transformed individuals generally have green rather than orange undertones. The eyes have vertical, diamond-shaped pupils. A slight fold of skin curves back from the eye to the corner of the mouth. The tympanum is not visible. This frog has no dorsolateral folds or glandular warts, although it may have small tubercles. The toes of the hind feet are short, but the webbing between them is even more extensive than it is in the Coastal Tailed Frog. The outermost hind toe is thicker than the other toes.



Adult male Rocky Mountain Tailed Frogs are 30 to 40 mm long and have a fleshy "tail", which is actually an extension of the cloaca. In the breeding season, males develop black pads on the hands and black tubercles on their arms and sides. Females are slightly larger than males and can reach 50 mm in length. See colour photograph 28.

Tadpoles of tailed frogs are slate grey with white patches and mottling. They grow up to 30 mm long. These tadpoles have large, suctorial mouthparts under the head. The mouth disc has broad, horny upper jaws and many labial teeth. It provides great suction for the mouth, enabling the tadpole to adhere to rocks in streams with fast currents so that it is not washed downstream. While holding on, the tadpole feeds on algae that it scrapes off the rocks with its rows of small teeth. See colour photograph 26.

Distinguishing Features: The Rocky Mountain Tailed Frog is very similar to the Coastal Tailed Frog: both have vertical pupils, lack spades or horny tubercles on the soles of the feet, and have no visible tympanum; males have a tail-like extension of the cloaca. But unlike its coastal relative, the Rocky Mountain Tailed Frog has fine black speckles on its dorsal and ventral surfaces and has slightly more extensively webbed hind feet.

Habits

Rocky Mountain Tailed Frogs are found in small mid-elevation mountain streams less than four metres wide. They do not inhabit streams on steep hillsides that tend to be seasonal and have fractured, unstable channels, as channel movement and displaced rocks in unstable streambeds will destroy adults and tadpoles. During the day, they hide under rocks beside the stream or in nearby rivulets. At night they forage in the surrounding forest. These frogs eat terrestrial and aquatic insects and forage under water as well as on land. They face predatory threats from snakes, fishes, birds, larger frogs, predatory invertebrates and small mammals.

Breeding

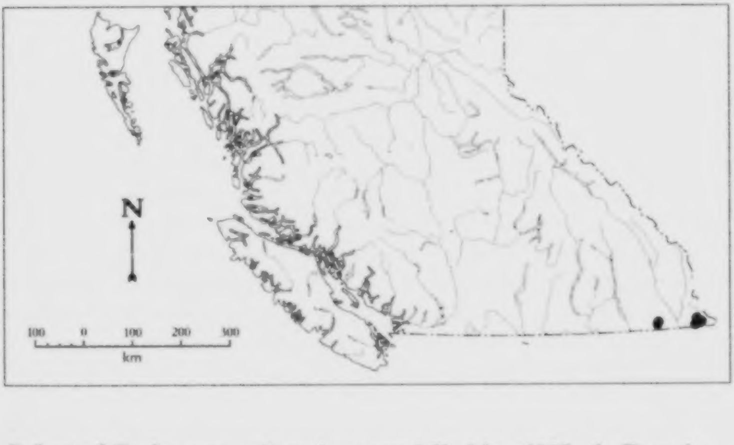
Rocky Mountain Tailed Frogs tend to breed in the fall, although they can mate year round. They do not vocalize and it is not known how mates find each other. During mating, the male clasps the female around the waist in pelvic amplexus and uses the tail-like extension of the cloaca for insemination; the male's vent is at its tip. After mating, the sperm remain viable within the female's oviducts until egg-laying many months later.

In midsummer the female can lay 45 to 75 clear, unpigmented eggs in small clusters, fixing them to the undersides of rocks in streams. The tadpoles stay in pools until their suctorial mouth is fully developed. Larger tadpoles inhabit swifter flowing parts of the stream. Tadpoles tend to metamorphose in pools with large boulders. They can take up to five years to metamorphose, and do so usually in early spring to late summer; see colour photograph 27. Transformed frogs usually reach sexual maturity in seven or eight years. These are the longest-lived frogs in North America, with an estimated life expectancy of 15 to 20 years.

Subspecies: None.

Range

The Rocky Mountain Tailed Frog is found in Canada only in the extreme southeast of British Columbia, in the southern Kootenay region. It occurs only in a few streams in both the Border Ranges and the Columbia Mountains, on either side of the Rocky Mountain Trench. The populations in the Border Ranges appear to be continuous with populations in adjacent Idaho and western Montana. It has not been recorded in Alberta.



Selected References: Daugherty and Sheldon 1982a, b; Dupuis 1998; Karraker et al. in press; Nielson et al. 2001.

FAMILY PELOBATIDAE

Great Basin Spadefoot Toad
Spea intermontana

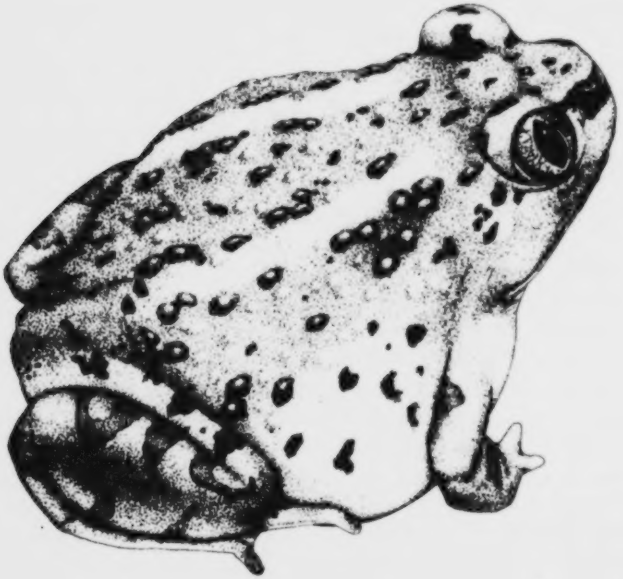
The Great Basin Spadefoot Toad has adapted to living in desert or semi-desert regions. It escapes from dry conditions mainly by burrowing. The sole of each hind foot has a single enlarged tubercle or "spade" that enables the toad to burrow efficiently by digging itself backwards into the ground. Many species of spadefoot toads breed explosively in temporary pools that form in heavy rains. Larvae feed voraciously on virtually any organic material. The tadpoles of some other species of spadefoot toads are carnivorous and cannibalistic, developing larger mouths and other distinctive morphological features.

Description

The Great Basin Spadefoot Toad is grey to olive-grey or tan, with two indistinct and irregular light bands bordering the back. It has several small tubercles or reddish-brown spots covering the back. The belly is dirty white, without markings. It has a round protuberance, called a boss, on top of its head between the large eyes. A blunt snout and raised nostrils give this toad a pug-faced appearance. The distinctive, brassy, cat's-eyes have vertical, lens-shaped pupils. The tympanum is small and indistinct. The legs are short and the hind feet partially webbed. The sole of each hind foot has a single, black "spade" – an enlarged tubercle. Great Basin Spadefoot Toads can grow up to 65 mm long; females are slightly larger than the males. Males have dark throats and develop black pads on their thumbs during breeding. See colour photograph 15.

The tadpoles of Great Basin Spadefoot Toads are large, up to 70 mm long, and from above appear iridescent steel-grey or gold. They have close-set, raised eyes, high tail fins, and pork-chop shaped, globular bodies. The triangular head is as wide or wider than the belly and appears to be distinct from the body.

Distinguishing Features: The blunt snout and the squat body with tubercles, but no warts or parotoid glands. Vertical pupils. A single, horny spade on each hind foot.



Habits

Great Basin Spadefoot Toads prefer sandy soils in dry grasslands and open woodlands, including meadows and sagebrush or bunchgrass prairies. In interior British Columbia, they are commonly associated with Bluebunch Wheatgrass (*Agropyron spicatum*), Douglas-fir (*Pseudotsuga menziesii*) and Ponderosa Pine (*Pinus ponderosa*). They can be found near lakes or permanent ponds in dry interior valleys, but they more often occur in open, semiarid to arid habitats, and will range far afield to higher elevations. Tadpoles have been found in ponds as high up as 1800 metres. Adults are abundant in some areas, but rarely seen during the day due to their burrowing habits and principally nocturnal activities.

Spadefoot toads may be active on summer nights if the soil is moist after rainfall. During the heat of the day, and particularly during dry spells, it burrows into the soil and remains dormant until suitable conditions return for survival above ground. Its physiological adaptations allow the spadefoot toad to lose up to 48 per cent of its body weight in water. Digging backwards using the spades on its hind feet allows it to push the soil aside to create a burrow. Underground, the toad's absorptive body allows it to absorb moisture directly from the soil through its skin, even from fairly dry soil. In British Columbia, Great Basin Spadefoot Toads begin hibernating in October.

Despite having potent and bad-tasting skin poisons, these toads are eaten by garter snakes, Burrowing Owls (*Athene cunicularia*), Coyotes (*Canis latrans*) and likely other large predators such as Great Blue Herons (*Ardea herodias*). Great Basin Spadefoot Toads eat a variety of invertebrates, including earthworms, ants, flies, beetles, crickets and grasshoppers.

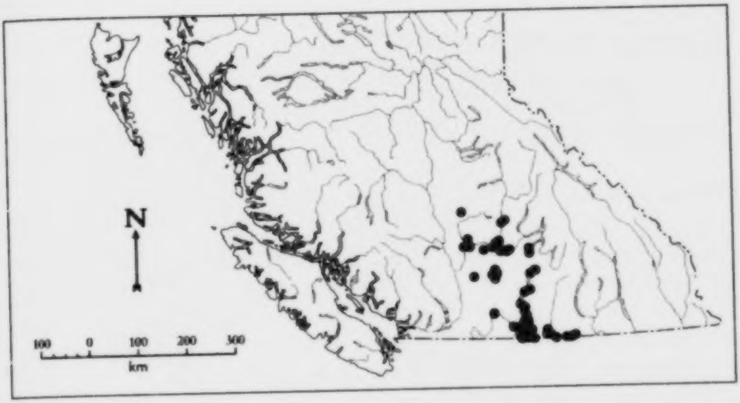
Breeding

Great Basin Spadefoot Toads breed in temporary pools or the shallows of lakes in early April through to June. Generally, they will wait for a rain before breeding. Breeding activity at a locality can last up to a month, but usually takes no longer than a week. The male's call is a rapid, insistent, duck-like "gwa gwa gwa gwa". Spadefoot toads usually call in large choruses, with each one calling in a different pitch, enabling it to be singled out. A large bilobed vocal sac distends beneath the chin when the male is calling. To mate, the male grasps the female around the waist in pelvic amplexus.

Females can lay up to 800 black eggs in clumps of 20 to 40 in shallow water; she attaches the clumps to sticks, pebbles or aquatic vegetation in the shallows of ponds. Hatching times depend on water temperature, being as short as two days in warm weather or as long as seven days during cooler weather. Growing rapidly, the tadpoles feed voraciously on anything organic, including algae, aquatic plants, dead fishes and even their own feces; they will also scavenge dead siblings. Carnivorous tadpoles, with an enlarged head and jaws, have been observed in other species of spadefoot toads in crowded conditions, but not yet in populations of the Great Basin Spadefoot Toad. Drying ponds in British Columbia's interior can hold thousands of tadpoles in extraordinarily dense aggregations.

The time of metamorphosis depends on water temperature, but most tadpoles transform at four to eight weeks of age (the average is about six weeks). The toadlets are 20 to 25 mm long and often still have a tail when they leave the water. Several hundred have been seen dispersing en masse from a pond or lake. Great Basin Spadefoot Toads reach sexual maturity in two to three years.

Subspecies: None.



Range

Great Basin Spadefoot Toads inhabit the intermontane region between the Rocky Mountains and the coastal ranges from northern Arizona to southern British Columbia. In British Columbia, they are found in the Okanagan Valley and the Nicola, north Thompson and central Similkameen river valleys of the dry interior as far north as 70 Mile House and Barriere, west through the Nicola River valley, and southeast through Midway as far as Christina Lake.

Selected References: Brown 1989, Cannings 1999, Dimmit and Ruibal 1980, Seymour 1973, Tanner 1989.

FAMILY BUFONIDAE

Western Toad *Bufo boreas*

Other Names: Boreal Toad, Northwestern Toad.

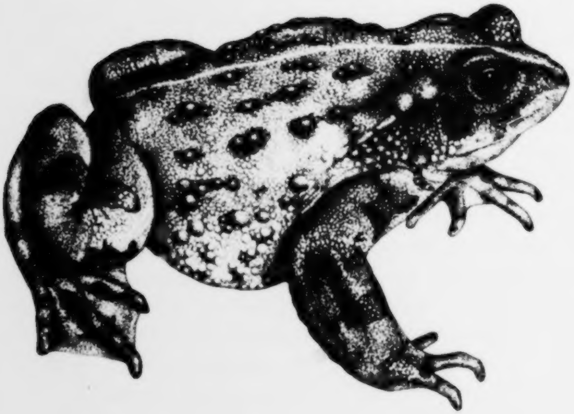
Toads are chunky amphibians adapted for life on land. They tend to have wartier skins and shorter legs than typical frogs. Horny tubercles on the hind feet enable them to dig themselves backwards into the ground to hide or escape dryness. Their characteristic warts are poison glands that secrete a foul-tasting toxin that deters most potential predators.

Description

Western Toads come in a variety of colours: brown, olive-green, grey, reddish-brown, yellow or black, and mottled or dappled in diffuse light and dark patches. Some have a variably defined light stripe, usually whitish or cream coloured running down the middle of the back. The belly is white, mottled with black spots or blobs. The throat is light cream coloured, similar to the belly. This toad has a tubercled grey pelvic patch of thin skin under the groin area that looks somewhat like a pair of dotted underpants. The gold-flecked eyes have horizontal pupils. A large, kidney-shaped parotoid gland is behind each eye. The ear membrane is small. The rough skin of the body and legs is covered with round, reddish warts; each calf has a large wart. The legs are relatively short. Each hind foot has two enlarged, horny tubercles on the sole and a glandular skin fold along the outside of the tarsus. The toes of the hind feet are partially webbed. Males have longer arms and narrower heads than females. In the breeding season, males develop smoother skin and black nuptial pads on their thumbs. Males reach 60 to 110 mm long; females are usually larger, up to 125 mm long. See colour photographs 19 and 20.

The tadpoles are small and black and grow to about 25 to 30 mm long before metamorphosing. Their eyes are close set on top of the head. The tail fin is rounded and does not extend onto the back.

Distinguishing Features: The conspicuous parotoid glands and the reddish-brown warts all over the back and legs. Horizontal pupils.



Habits

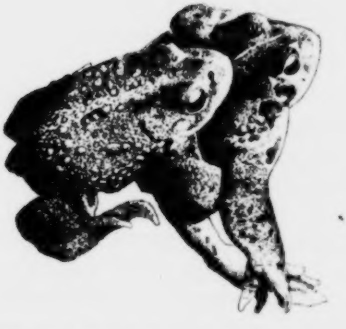
Western Toads can be found in fields, forests, meadows and a wide variety of wetland habitats. As they are more tolerant of dry conditions than most frogs, they can roam relatively far from standing water, but prefer damp conditions and cannot tolerate extreme dryness. During dry periods in summer, they seek out moist terrestrial habitats, or look for a depression in the ground, possibly an old rodent burrow, and wait until conditions are more suitable. Their warty skin is moderately resistant to desiccation while the thin skin of the pelvic patch under the belly enables them to absorb moisture from the ground. They are most active at night and are most often seen in the evenings when they emerge from their hiding places to forage. Their food consists of worms, slugs and insects but they will eat larger animals if given a chance. Western Toads do not seem to occur in heavily urbanized areas but they do well in rural farming districts.

Few animals other than some snakes will eat an adult toad. When frightened, a Western Toad will first try to hop away. If that fails, it will rear up on all fours, puff itself up and tuck its head down. This defensive posture presents the poison-carrying parotoid glands and warts to the attacker. The poison is purely for defence. Toads have no teeth and will not attack or try to bite. A severely agitated or injured toad can voluntarily exude the white poison from its skin glands. The poison is acrid and bitter and causes a burning sensation or numbness when in contact with another animal's mouth or lips. If picked up, the toad will urinate on its captor. The major predators of Western Toads in British Columbia are garter snakes, which can tolerate this poison. Small mammals as well as ducks and other birds feed on tadpoles, as do various aquatic invertebrates, but rarely fish.

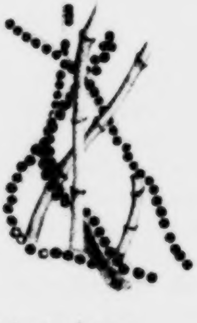
Breeding

In the spring, Western Toads congregate in small ponds or pools, usually with shallow water and a sandy bottom. They will even breed in temporary pools beside lakes or rivers. Breeding sites are traditional locations where toads return year after year. Male toads in British Columbia have no mating call, although a mating call has been reported from breeding Western Toads in Alberta. Without such a call, males search the breeding pond, day or night, for prospective mates. With their strong arms, they will clasp anything that resembles a female toad, including large sticks and bewildered frogs. When a male Western Toad is grabbed by another male, he chirps vigorously until released. Males will chirp at any time of the year if they are grasped around the body or under the arms. Females, though, are always silent and do not chirp or protest when clasped. Amplexus is pectoral. This toad exhibits no territorial behaviour.

Females lay eggs in strings that can be several metres long, usually entwined around submerged vegetation. One large female can produce more than 12,000 eggs in a clutch. Hatchlings emerge in a week to 10 days, depending on water temperature. The tadpoles develop rapidly and transform into 10-mm-long toadlets in 6 to 10 weeks, also depending on water temperature. The tadpoles form

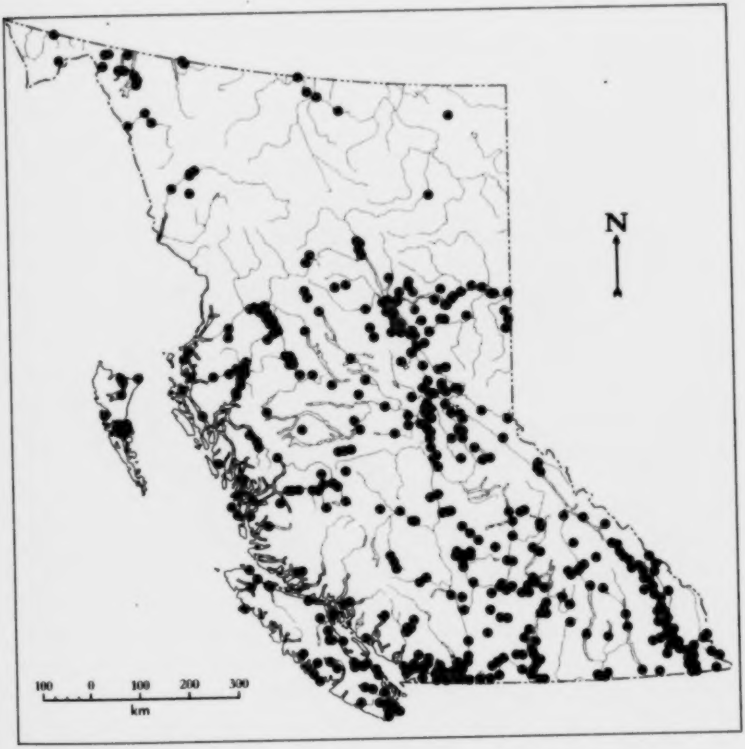


Western Toads in amplexus.



Strings of eggs.

feeding clumps or synchronized schools consisting of individuals from several clutches all swimming together. The tadpoles in these schools sometimes number in the millions. Tadpoles often swim in the warmest, shallowest areas of water – their black bodies are thought to absorb heat from the sun, which enhances their growth and development. In midsummer, large aggregations of transforming tadpoles and toadlets gather around the banks of the breeding pond where they fall easy prey to garter snakes and birds. Large numbers of tiny toadlets can be found moving overland after transformation, or gathered in cracks in drying mud along the edge of a pond. In late summer, many juvenile toads have bright yellow foot tubercles. Male Western Toads reach sexual maturity within three years, females in four to five years. Western Toads can live up to eleven years.

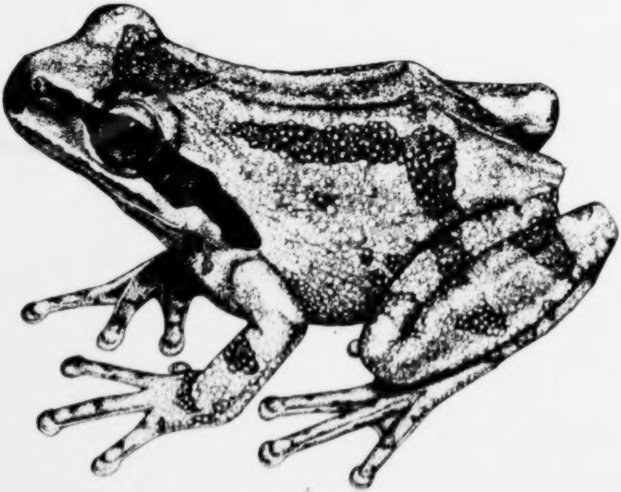


Subspecies: There are two subspecies. Only the Boreal Toad (*Bufo boreas boreas*) occurs in British Columbia.

Range

Western Toads are found from southern Alaska to Baja California, as far east as the Rocky Mountains, and in Colorado and Utah. In British Columbia, they are found throughout the province, including Vancouver Island. Western Toads are the only amphibians native to the Queen Charlotte Islands.

Selected References: Brown 1977, Chivers et al. 1999, Marco et al. 1998, Olson 1989, Olson et al. 1986.



Pacific Treefrog

FAMILY HYLIDAE

Pacific Treefrog *Hyla regilla*

Other Names: Pacific Chorus Frog, Pacific Treetoad; *Pseudacris regilla.*

Treefrogs are agile, long-legged frogs that have sticky pads on the tips of their fingers and toes enabling them to climb about in trees and shrubs. They can even cling to walls and windows. An extra, intercalary bone or cartilage between the last two bones of each digit gives the pad greater flexibility. Pacific Treefrogs have evidently adapted well to suburban settings and are often heard calling from backyards and ponds.

Description

A Pacific Treefrog can change its colour rapidly, from bright green to deep olive-brown or almost any shade of green or brown in between. Populations also show substantial colour variation among individuals. This frog has a pattern of dark spots or blotches on the head, back and legs, which usually forms a dark V- or Y-shape between the eyes; but this pattern fades when the frog is lightly coloured and obscures when the frog is dark. Always present and obvious is a dark stripe, called the eye stripe, that extends from the nose, through the eye, across the tympanum to the shoulder. Occasionally, an individual with bright bronze or reddish colouring on the back turns up in a population. The Pacific Treefrog's belly is white or pinkish and unmarked. The skin of the back is smooth, but the belly skin is granular in appearance. It has no warts. A fold of skin crosses the chest between the front legs. The pupils are horizontal. The legs are long and slender. The toes of the hind feet have small webs between them. Each digit on the front and back feet has a round, sticky toe-pad on the tip. Males have a dark olive throat and can measure 25 to 40 mm in length; females can reach 50 mm long. See colour photographs 17 and 18.

The tadpoles are light greenish-grey, up to 45 mm long, and have high tail fins. They can appear iridescent when viewed ventrally. The eyes are widely spaced and set on the outer margin of the head. The internal viscera can be seen through the skin of the belly, which is longer and wider than the head.

Distinguishing Features: This is the only amphibian in British Columbia with prominent adhesive toe-pads. A treefrog can change its colour, but the dark eye stripe always remains; the stripe does not extend to the groin, as it does on the Boreal Chorus Frog.

Habits

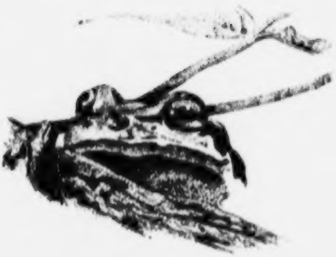
The Pacific Treefrog can climb trees, bushes, walls and houses using its adhesive toe-pads. These round discs on the tips of the toes have a thick, specialized epidermis made up of microscopic wedge-shaped cells that penetrate cracks and other irregularities in the surface being climbed. Treefrogs are agile and adept climbers and can sometimes be found high above the ground, although for the most part they forage in low bushes or shrubs. They will sometimes sun themselves on exposed leaves, adopting a posture that minimizes the surface area of the exposed skin. During the summer, they can venture far from standing water. On a humid or rainy summer day, a treefrog may announce its presence from a tree or bush with a "rain song", a shortened single-note version of the mating call. Pacific Treefrogs generally inhabit open woods or forest margins, avoid extreme dryness, and are tolerant of farming and suburban development.

A Pacific Treefrog changes colour when the pigment cells of its skin expand or contract. These colour changes relate to the surrounding temperature and humidity, not the colour of the place where the frog is sitting. Thus, on a warm, dry day the treefrog will usually turn a light shade of brown or green and so will more likely match the colour of the warm, dry leaf it is sitting on. Conversely, a cold, damp treefrog will turn dark.

Pacific Treefrogs eat a variety of crawling and flying insects. A treefrog lunges at its prey tongue-first, and if it misses it will momentarily struggle to detach its sticky tongue from the surface it is stuck to. Pacific Treefrogs are prey to garter snakes, birds, Bullfrogs, fishes and small mammals.

Breeding

The male Pacific Treefrog's mating call is a two-note "kreck-ek!", repeated continually. This call is familiar to almost everyone as the original "ribbet" sound in many Hollywood movies, because the Pacific Treefrog occurs in Los Angeles and was easily recorded. Amplified by a large, round vocal sac inflated beneath the chin, the call is astonishingly loud for so small an animal. A large chorus of treefrogs in the spring can be heard for several kilometres and will



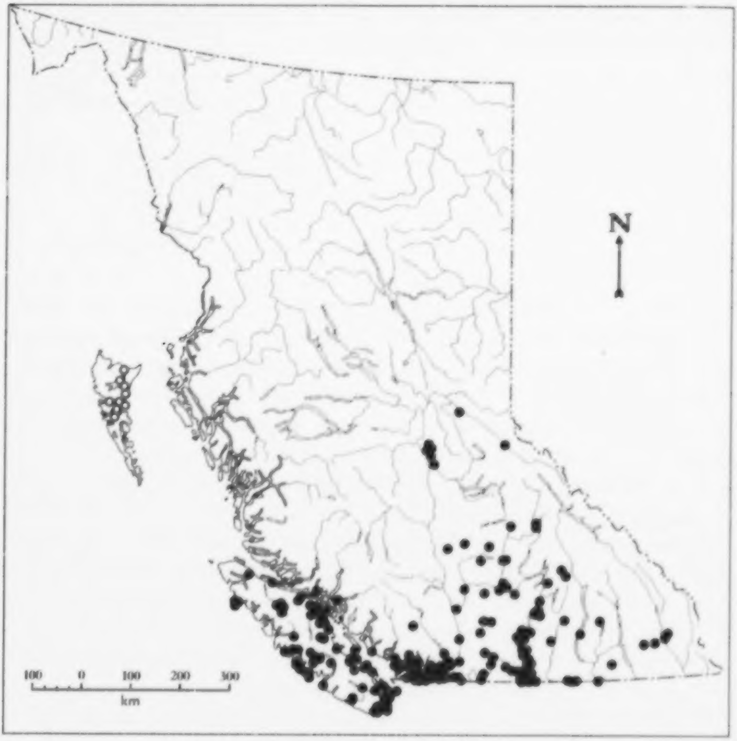
drown out the vocal attempts of other frogs and toads. The male treefrog selects a calling site near water and sings from there to attract a mate. The female must approach and sometimes actually touch the calling male before he will react to her presence and attempt to clasp her. His call switches to a single note when another male frog is near. Male treefrogs have a complex repertoire of calls used for mating, territoriality and release. Amplexus is pectoral and can last several hours. The mating calls also act as territorial signals and to separate competing males; if too close to each other, two males may wrestle to establish ownership of their preferred site.

Females lay loose clusters of up to 70 eggs in and around submerged vegetation. Pacific Treefrogs can breed in a variety of aquatic environments – roadside ditches, flooded dirt roads and fields, even stagnating tidal pools inundated with rainwater. Typical habitats are shallow, seasonal or permanent ponds, swamps, or slow-moving water courses. One female can lay several egg clusters per season throughout a pond. Eggs take about a month to hatch, and in two to three months, the tadpoles transform into tiny treefrogs about 15 mm long. These reach maturity in about a year.

Subspecies: None.

Range

Pacific Treefrogs are found from Vancouver Island and southern British Columbia to southern Arizona and Baja California. Their range extends from the Pacific coast to western Montana, Idaho and Nevada. In British Columbia, they can be found across the southern third of the province as far north as Quesnel and McBride and as far east as Cranbrook. Pacific Treefrogs have been introduced into the Queen Charlotte Islands. The son of a long-time Graham Island resident released a jar of tadpoles that he had collected at Como Lake on Vancouver Island. Apparently he "liked to hear them sing".



Selected References: Brenowitz and Rose 1999, Cocroft 1994, de Vito et al. 1999, Jameson 1956, Reimchen 1990, Schaub and Larsen 1978, Whitney and Krebs 1975.

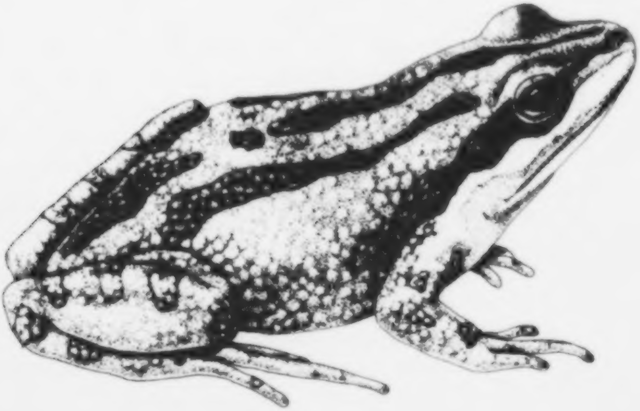
Boreal Chorus Frog *Pseudacris maculata*

Other Names: Northern Chorus Frog, Striped Chorus Frog, Swamp Treefrog.

The Boreal Chorus Frog is the smallest frog in British Columbia. It is a close relative of the arboreal treefrogs but has assumed more terrestrial habits. Although they still have the extra intercalary bone in each digit, which is characteristic of treefrogs, chorus frogs do not have large, sticky toe-pads on the tips of the fingers and toes. Like the Wood Frog, the Boreal Chorus Frog is capable of surviving sub-zero temperatures while overwintering. A high concentration of glucose in its blood acts as a cryoprotectant preventing damage to tissues as the animal freezes.

Description

The Boreal Chorus Frog is small and grey, olive-green, tan or copper coloured, with three distinct darker stripes along the back. The middle dorsal stripe is sometimes broken into smaller patches or spots. A black stripe runs along each side of the head and body from the nose, through the eye and along the side of the body to the groin. A cream stripe runs along the upper jaw. The belly is cream or light tan. While the skin of the back is smooth, the belly skin is distinctly granular in appearance. There are no dorsolateral folds or warts. The snout is somewhat pointed. The body is elongated but the hind legs are comparatively short. The hind feet have



long toes with small webs between them. Toe-pads are not noticeable. Males have dark, greenish-yellow throats and are slightly smaller than the females. Boreal Chorus Frogs grow to between 20 and 40 mm long. See colour photograph 16.

The tadpoles are small, up to 30 mm long, and grey or brown flecked with gold. They have widely spaced eyes, large nostrils and a high tail fin that extends along the back. The belly is smaller and narrower than the head.

Distinguishing Features: Small frog with a long body and disproportionately short legs. Three irregular or broken stripes down the back, and dark stripes on the sides that extend from the nose to the groin.

Habits

Boreal Chorus Frogs inhabit damp grassy or wooded areas and spend drier periods underground or under leaf litter or woody debris. They can be found above ground during the fall and they sometimes call before winter weather sends them into dormancy. Otherwise, they are difficult to see outside of their breeding season. Little is known of their habits, especially in northern parts of their range, including British Columbia. In the breeding season, they can be found almost anywhere there is shallow standing water. Where they go after mating is uncertain. They eat ground-dwelling insects and invertebrates.

Breeding

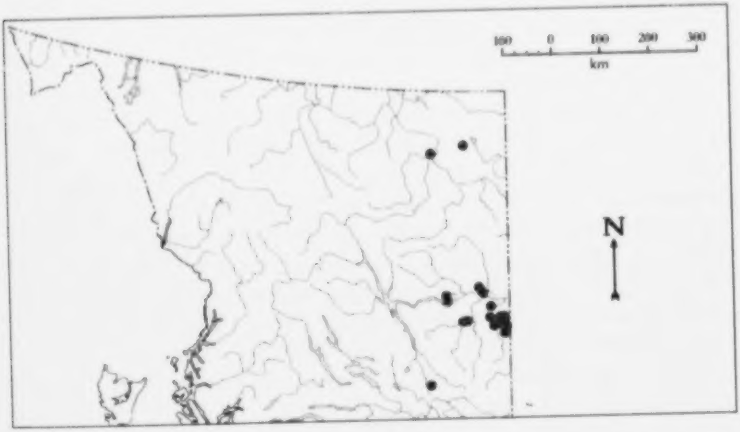
Males begin calling even before all the snow melts in early spring. They call from ponds, ditches or meltwater puddles that are still almost entirely ice-covered. In northern British Columbia, they begin breeding in early May and will continue to call through June. Because they sing so early in spring, Boreal Chorus Frogs are sometimes mistakenly called Spring Peepers, a name more usually applied to an eastern species, *Pseudacris crucifer.* Boreal Chorus Frogs call all day in early spring and may sing continually night and day at the height of the breeding season. The male has a large, round, yellowish vocal sac that allows it to produce remarkably loud calls despite its small size. The call is a vibrating "krreeeeeep!" that rises steadily in pitch and is repeated about every two seconds – it sounds like someone stroking the teeth of a stiff plastic comb. Boreal Chorus Frogs usually call while concealed among the mats of dead grass or other vegetation, with only their heads protruding above water, making them extremely difficult to see. When a singing male is approached by a female, he clasps her in pectoral amplexus.

Females lay small eggs, less than 2.5 mm in diameter, in long, dense clumps attached to submerged vegetation, usually in shallow, temporary pools. The tadpoles develop rapidly and transform in about two months. The little chorus frogs reach maturity the following year. It is possible that Boreal Chorus Frogs live for no more than one or two years in the wild.

Subspecies: None.

Range

Boreal Chorus Frogs range over North America east of the continental divide from Great Bear Lake to the shores of Hudson Bay and James Bay in Ontario and from Lake Superior across the northern Great Plains to northern New Mexico in the southwest. In British Columbia, they occur only in the northeast, in the Peace River region.



Selected References: Hoppe 1978, MacArthur and Dandy 1982, Platz 1989.

FAMILY RANIDAE

Members of the family Ranidae are good jumpers and usually the ones that leap into the water when you walk alongside a pond or stream. *Rana* is Latin for "frog", and members of this family are sometimes referred to as true frogs. Ranid frogs are found on every continent except Antarctica.

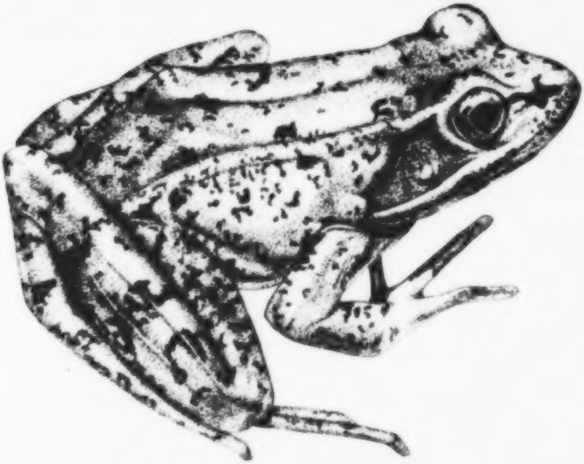
Red-legged Frog *Rana aurora*

The Red-legged Frog and most other frogs of the genus *Rana* are adapted for an aquatic or semi-aquatic life. They have smooth skin and long legs with fully webbed hind feet.

Description

This handsome frog is brown to reddish-brown on the back and covered with many small black spots. The prominent dorsolateral folds that run down each side of the back are a lighter shade of brown. Each side of the face has a dark mask above a narrow, cream-coloured jaw stripe. The throat and chest are white and usually flecked with black. Adult Red-legged Frogs have red on the lower belly and undersides of the legs, which grows more intense with age and sometimes extends onto the sides of the body. Juveniles have little or no red until they mature. The skin on the underside of the legs is translucent so that the musculature and bones of the lower leg are visible. On the flanks in the groin area is a mottled patch of yellowish-green with black blotches. The arms and legs are darkly barred on the upper surfaces. When adpressed, the hind leg's heel extends past the snout. The gold eyes are not markedly upturned as in the spotted frogs, but rather look out to the sides. The sexes are difficult to distinguish, although males have dark thumbs in the breeding season and are smaller than the females. Male Red-legged Frogs can reach 70 mm long and females 100 mm. See colour photographs 30 and 31.

The tadpoles are greenish-brown with numerous light and dark flecks on the back. The belly is creamy white with a pinkish tinge and flecked with small coppery or silvery spots. The eyes are close-set on top of the head. The tadpoles can reach about 70 mm long before transforming into little frogs.



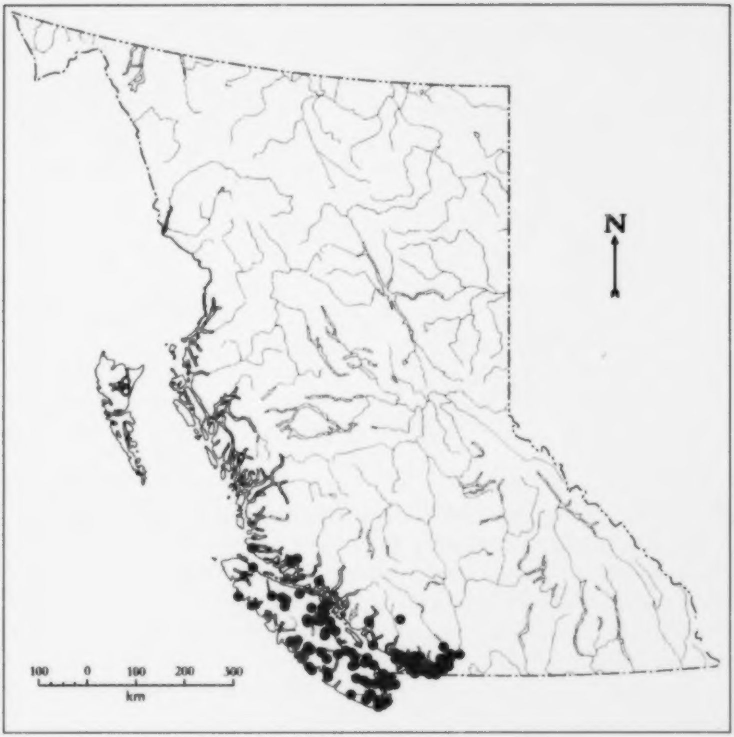
Distinguishing Features: The brownish back and dark facial mask. Bright red on the belly and underside of the legs of mature adults (though juveniles have little or no red). The translucent skin on the underside of the hind legs, allowing the bones to show through. The green patches and black blotches on the sides of the groin. Eyes not noticeably upturned.

Habits

In British Columbia, most Red-legged Frogs inhabit forests, often beside lower elevation wetlands. Although they breed in larger bodies of water, they spend most of the year in small, quiet pools, swamps or ponds in or beside a sheltering damp forest. If spooked, they jump into the water and usually swim to the bottom. They often wander far from standing water into the forest and sometimes can be seen during the day along forest trails near damp valley bottoms. Their reddish-brown colour helps them to blend into the litter of Western Redcedar (*Thuja plicata*) and Western Hemlock (*Tsuga heterophylla*) forests. Red-legged Frogs eat small insects and other forest invertebrates.

Breeding

Red-legged Frogs have a short breeding season that starts soon after they emerge from hibernation in mid February or March. Males call from beneath the water, spacing themselves a few



metres apart. The call is a short, feeble stutter something like "uh uh uH UH", lasting a little more than a second. Rarely can it be heard over the noisy choruses of Pacific Treefrogs, which often breed at the same time. The vocal sac is internal and only noticeable as a swelling of the frog's throat and neck during a call. When mating, the male grabs the female in pectoral amplexus, while repeatedly emitting a single, low-pitched call.

Females lay eggs in a large, globular mass the size of a grapefruit or cantaloupe, attached to submerged vegetation. The egg mass contains 500 to 1100 eggs. The tadpoles transform in midsummer into froglets about 25 mm long that will mature in two to three years.

Subspecies: There are two subspecies. Only the Northern Red-legged Frog (*Rana aurora aurora*) occurs in British Columbia.

Range

Red-legged Frogs are found west of the coastal mountain ranges of western North America from southern British Columbia to northern Baja California. In British Columbia, Red-legged Frogs occur on Vancouver Island and the adjacent mainland, the Gulf Islands, the Greater Vancouver area and along the Fraser River valley to Hope. They have been introduced on Haida Gwaii (Queen Charlotte Islands) around Port Clements.

Selected References: Calef 1973; Gregory 1979; Kiesecker and Blaustein 1997, 1998; Licht 1969, 1974, 1986.

Columbia Spotted Frog *Rana luteiventris*

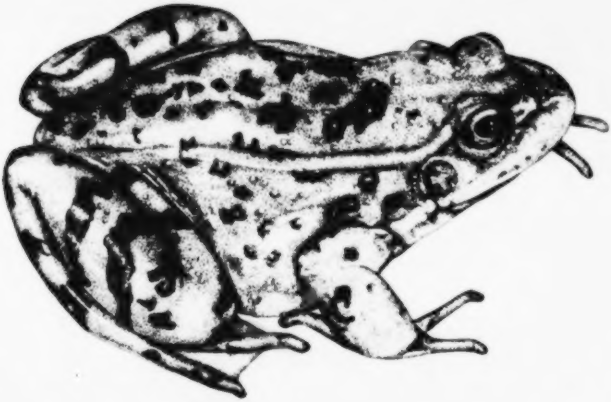
Other Names: Spotted Frog, Western Spotted Frog.

The Columbia Spotted Frog and Oregon Spotted Frog are almost identical in appearance and were differentiated as separate species only in 1997. Any reference in the literature to Spotted Frogs (*Rana pretiosa*) published before 1997 and referring to populations east of the Cascade Mountains is about the Columbia Spotted Frog (*R. luteiventris*). Both species of spotted frogs, the Red-legged Frog and the Cascades Frog, whose range just approaches the British Columbia border, comprise a group of similar-looking, difficult-to-distinguish western North American brown frogs that have faint masks and some red, orange or yellow on the belly and legs.

Description

The Columbia Spotted Frog is olive, light brown or tan, and has black spots with light centres scattered over its back. The sides are mottled with black and may have small reddish tubercles. Sometimes, only the faintest hint of a dark face mask is present. A light tan stripe on the upper jaw reaches to the shoulder. The undersurface is opaque white, painted over with red, salmon or orange pigment on the lower belly and legs. There are no other markings on the belly. The red pigmentation spreads over the whole underside and onto the throat in the largest individuals and intensifies with age. Small froglets, though, are only white on the belly. Green mottling is absent from the flanks and groin. From the front, the eyes look slightly upward. The snout is modestly pointed. The body is robust. Frogs in northern regions may have shorter legs than their southern counterparts. The hind feet have large webs that extend to the tips of the toes. Dorsolateral skin folds run along each side of the back, but they are not always distinct and disappear along the lower back. Males have enlarged thumbs in the breeding season but otherwise are similar to the females. Adult males measure 50 to 70 mm long, and females can reach 90 mm. See colour photographs 32 and 33.

The tadpoles are similar in shape and colour to the tadpoles of the Red-legged Frog (see page 134), but not so heavily spotted. They can reach 60 to 70 mm in length.



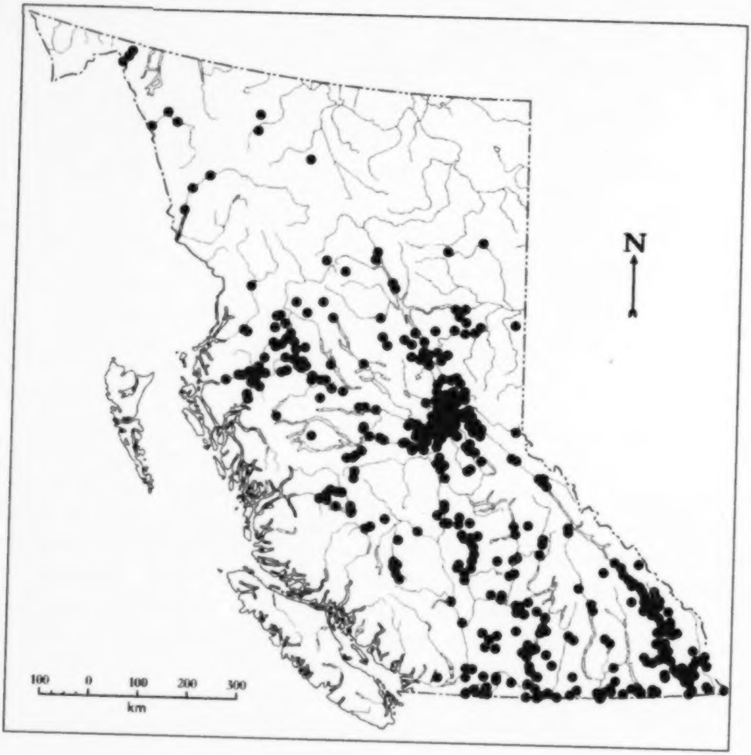
Distinguishing Features: Oregon and Columbia spotted frogs have upturned eyes when viewed head on, unlike other brown spotted frogs. Their leg bones are not visible through the skin and they have no green in the groin. Juveniles are olive-green rather than brown. Larger individuals of both species have red on the belly and hind legs: on Columbia Spotted Frogs, the skin is white with no mottling, but on Oregon Spotted Frogs, the red appears painted on slightly mottled skin. Columbia Spotted Frogs in the western part of the range do not have any dark ventral mottling.

Habits

Columbia Spotted Frogs are mostly aquatic, living in permanent ponds, small lakes and slow moving streams. They tolerate cold waters and range far to the north and up to the tree line in elevation. Commonly active during the day, they sometimes forage in meadows or damp woods, but never stray far from water. These frogs are usually unwary and sluggish. They eat whatever small prey happens by, mostly insects and spiders, but also snails, crustaceans and even millipedes. Columbia Spotted Frog tadpoles sometimes aggregate in dense schools of thousands.

Breeding

Columbia Spotted Frogs breed early in the spring, usually before the ice has fully disappeared from the surface of the breeding ponds, from early April to mid May in southern interior British



Columbia to as late as mid June in the north or at high elevations. The males station themselves along the shore and call with their heads just out of the water. Their voices are low in pitch and volume and have little carrying power. A full chorus of Columbia Spotted Frogs can sound like a quiet whisper over the surface of the water. Consisting of a series of seven to nine short grunts of increasing intensity, a call typically lasts about a second and a quarter. The males increase the number of grunting notes per call in territorial disputes. The vocal sac is internal. The breeding period is quite short and lasts two weeks at most. In the far north of its range, like many northward ranging amphibians, the Columbia Spotted Frog's breeding activity frequently extends throughout the daylight hours and can be over in a matter of days. During mating, the male clasps the female in pectoral amplexus.

Females lay eggs in communal masses at the surface of the water, either freely floating or loosely tangled around emergent vegetation. The tadpoles usually transform in late summer of the same year that they hatch, but those in the north may overwinter as tadpoles. The newly transformed froglets are about 25 to 30 mm long and will reach maturity in four years for the males and five years for the females.

Subspecies: None.

Range

Columbia Spotted Frogs are found between the Rocky Mountains and the Coast and Cascade ranges from northern British Columbia and the Alaska panhandle to southern Oregon, Nevada and Utah. They inhabit all of British Columbia east of the Coast Mountains, except the Peace River district. They approach the coast down the Stikine, Nass and Skeena rivers in the north, and the Chilliwack and Fraser rivers in the south to Chilliwack and Stave lakes.

Selected References: Bull and Hayes 2000; Green et al. 1996, 1997; Munger et al. 1998; Reaser 2000.

Oregon Spotted Frog *Rana pretiosa*

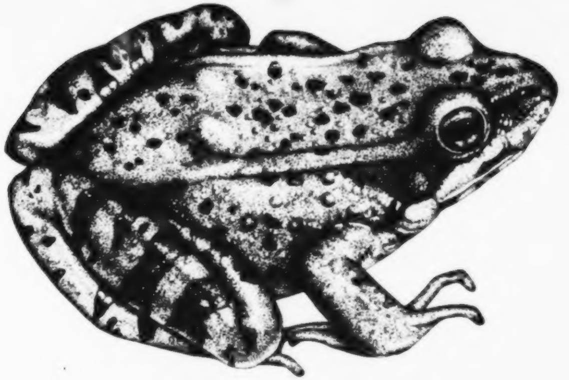
Other Names: Spotted Frog, Western Spotted Frog.

The Oregon Spotted Frog is the rarest amphibian in British Columbia, known to inhabit only three sites in the lower Fraser River valley. It is considered endangered throughout its range. It has only recently been distinguished from the Columbia Spotted Frog (*Rana luteiventris*). Published references to Spotted Frogs (*R. pretiosa*) dated before 1997 discussing populations west of the Cascade Mountains are about the Oregon Spotted Frog (*R. pretiosa*).

Description

Oregon Spotted Frogs are medium brown to reddish-brown on the back with scattered light-centred black spots. The sides are mottled with black and may have small reddish tubercles. The frogs become increasingly reddish with age; juveniles are olive green or light brown. Most have the faintest hint of a dark facemask. A light tan stripe on the upper jaw reaches to the shoulder. Light brown to orange dorsolateral skin folds run along each side of the back. The folds are reasonably distinct behind the eye until about the middle of the back, beyond which they become discontinuous and disappear altogether on the lower back. The undersurface is white with a faint grey mottling and a fragmented wash of red, salmon or orange pigment that looks painted on the lower belly and legs. This belly colour intensifies with age – small froglets may have none, but the largest individuals can have it spread over the whole underside and onto the throat. No green is present on the flanks or groin. When viewed from the front, the eyes point slightly upward, giving the frog a dull-witted expression. The snout is pointed and the body is robust. The hind feet have large webs that extend to the tips of the digits. Males can grow up to 65 mm long and have enlarged thumbs in the breeding season; otherwise they are similar to the females, which can reach 80 mm in length. See colour photograph 24.

The tadpoles are similar in shape to the tadpoles of the Red-legged Frog, but they are not as heavily spotted and have slightly longer tails. They can reach 60 to 70 mm long. The tadpole's belly is slate grey or white without the brassy or gold flecking present in Red-legged Frog tadpoles.



Distinguishing Features: The upturned eyes (when viewed head on) distinguish Oregon and Columbia spotted frogs from other brown spotted frogs. The leg bones are not visible through the skin and they have no green in the groin. Juveniles are olive-green rather than brown. Larger individuals of both species have red on the belly and hind legs: on Oregon Spotted Frogs, the red appears painted on slightly mottled skin, but on Columbia Spotted Frogs, the skin is white with no mottling.

Habits

Oregon Spotted Frogs are much more aquatic than Red-legged Frogs. They are particularly unwary and sluggish, and easy to approach. If spooked, they will usually swim to the bottom of the pond a short distance away and lie there motionless.

The Oregon Spotted frog inhabits frequently flooded marshes next to forest, usually with both permanent water and shallow, ephemeral pools nearby.

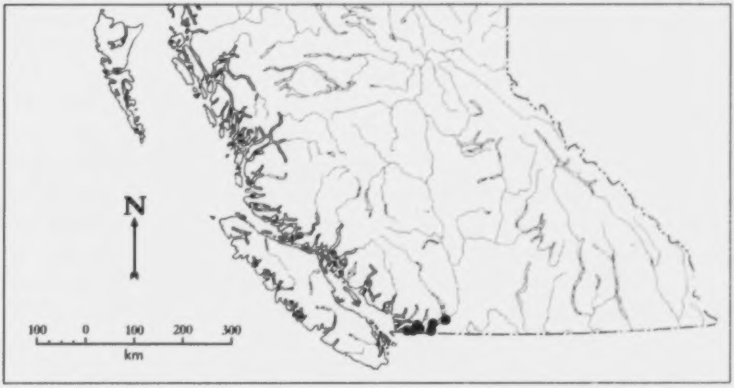
Breeding

Oregon Spotted Frogs breed in February or March in British Columbia when the water temperature may be just above freezing. Males call from under the water and their voices are low in pitch and volume with little carrying power. A call typically consists of a series of around 25 short clucks of increasing intensity, lasting about a second and a half. The vocal sac is internal. The male clasps the female in pectoral amplexus and fertilizes the eggs as the female lays them. Females lay a single egg mass each year consisting of over 600 eggs. They lay their egg masses communally at the surface of shallow water, with each one laying hers alongside or on top of the egg masses already there. The breeding period lasts only a couple of weeks. Tadpoles transform in less than four months. Newly transformed froglets are about 30 to 35 mm long and will reach maturity in two to three years.

Subspecies: None.

Range

Oregon Spotted Frogs range from the lower Fraser River valley of British Columbia south through the Puget Sound lowlands and Willamette River valley of Oregon west of the Cascade Mountain crest just into northern California. But they are now absent from 90 per cent of this historic range. In British Columbia, they have been recorded at just seven sites in the lower Fraser River valley, but are now known to occur at only three sites in the vicinities of Abbotsford, Agassiz and Seabird Island.



Selected References: Green et al. 1996, Green et al. 1997, Licht 1969, McAllister and Leonard 1997.

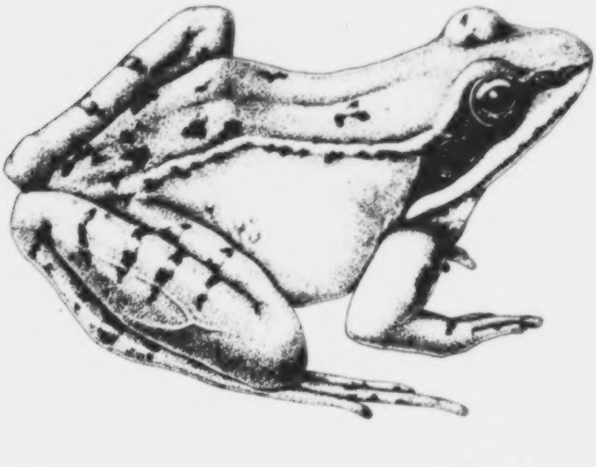
Wood Frog *Rana sylvatica*

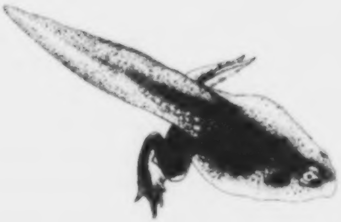
Other Names: Northern Wood Frog.

The Wood Frog is more widespread and found further north than any other amphibian in Canada. It is the only North American amphibian to range past the Arctic Circle. Its exceptional tolerance of cold and frost and its accelerated larval development help it to cope with northern climates and short growing seasons.

Description

The Wood Frog is small and has several colour variations but always a black mask that covers the tympanum and contrasts sharply with a white stripe along the upper jaw. Its colour varies from light tan to grey to deep brown and can be uniform or have dark spots or mottling on the back and sides. Some Wood Frogs have a narrow, bright white stripe running down the middle of the back from the snout to the vent; if present, this stripe is obvious. Its frequency of occurrence varies among members of different populations. The belly is white with dark flecks at the sides and on the throat occasionally extending onto the chest. The skin is smooth, but there may be scattered brown tubercles on the sides. Glandular dorsolateral folds run down the sides of the back. The hind legs are barred with dark pigment and are quite short, especially in frogs





from further north. The undersides of the thighs are white. Males and females look similar. Mature Wood Frogs measure 35 to 50 mm long, with the females slightly larger than the males. See colour photograph 29.

The tadpoles are grey, black or dark brown and can grow up to 50 mm long. They have a short, round body with a short snout. They have high tail fins up to twice as long as the body and extending well-forward onto the back. Their eyes are widely spaced on top of the head. Some have a bronze iridescence on the sides and bright gold flecks in lines appearing like whiskers radiating from the sides of the mouth.

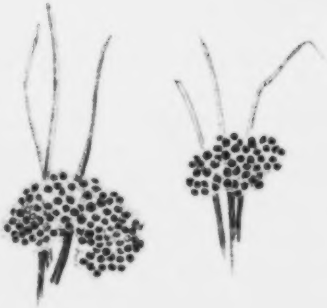
Distinguishing Features: The small size for a brown, coppery or grey frog. The distinct black mask and white underparts. On some, dark markings on the back, or a bold, white mid-dorsal stripe.

Habits

Wood Frogs can be found in forests, fields and muskegs. In summer and fall, they are terrestrial and will forage far and wide through damp forest for insects and other invertebrates.

The Wood Frog is a highly adaptable amphibian in northern climates and can tolerate low temperatures. It escapes from winter's cold by hibernating on land underneath the forest litter and humus, relying in part on the insulating powers of snow to keep the upper layers of the ground from freezing. But like the Boreal Chorus Frog, the Wood Frog is capable of surviving in winter even when the temperature of its immediate surroundings falls below freezing. The frog lets its body temperature drop without allowing ice to form. Should it get even colder, the frog can tolerate being frozen: when it begins to freeze, the formation of ice crystals triggers it to metabolize its large store of liver glycogen into glucose, which enters the blood; the high concentration of blood glucose is a cryoprotectant that limits the growth of ice crystals and keeps the body's tissues from damage. A frog can survive many days in a frozen state, exhibiting no outward signs of metabolism and a heartbeat so slow that it is barely discernible.

Breeding



Early in the spring, usually well before all the ice on the ponds has melted, Wood Frogs begin their short breeding season. They can breed at temperatures just above freezing, far too cold for most other amphibians and reptiles. Breeding activity occurs throughout the daylight hours for a few weeks in more southerly parts of the Wood Frog's range and only a few days towards the north. Males congregate in shallow, clear ponds and call day and night as long as the temperature remains above freezing. They have small, paired vocal sacs, one on each side of the head, that balloon out above each arm. The call is a loud, duck-like quack. There does not appear to be any territorial behaviour in a breeding congregation of Wood Frogs. Amplexus is pectoral.

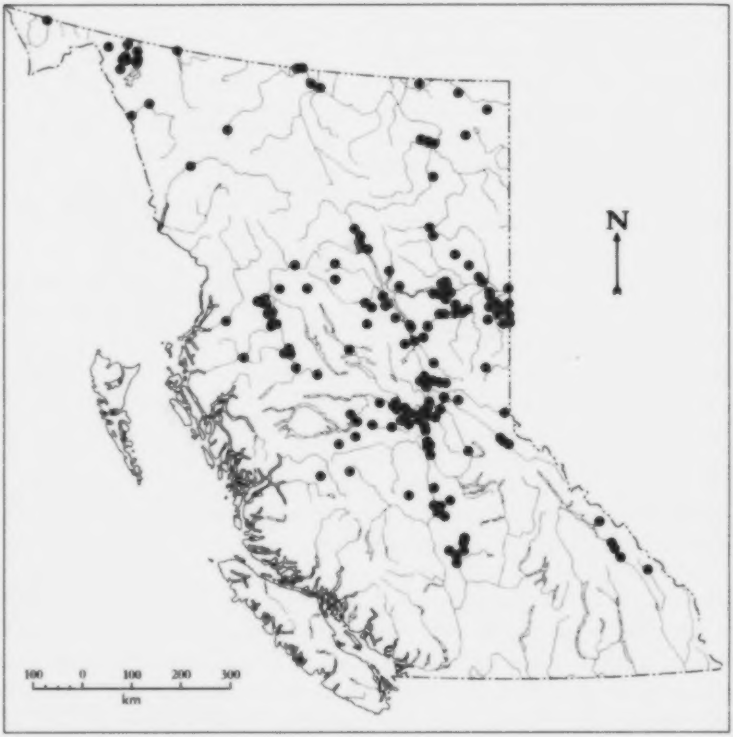
A female lays from 40 to more than 1500 eggs in a globular mass, attaching it to submerged sticks or plants or lying it freely in the water, often close to several other egg masses. After the eggs are laid, the frogs disperse into the surrounding forest. The tadpoles grow quickly, even at comparatively low temperatures, and are able to transform into little Wood Frogs by midsummer.

Subspecies: None.

Range

Wood Frogs are found across most of Canada and the northeastern United States from the Appalachian Mountains and the Maritime provinces across Quebec, Ontario and the prairies to most of the Yukon, Northwest Territories and Alaska, crossing the Arctic Circle. In British Columbia, they are mainly found over the northern half of the province to the east of the Coast Mountains and range through the Cariboo region to Clinton and through the Rocky Mountain Trench to Kootenay National Park. (Map on following page.)

Selected References: Brooks et al. 1999, Forester and Lykens 1988, Howard 1980, Sagor et al. 1998, Young 1988.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Wood Frog distribution.

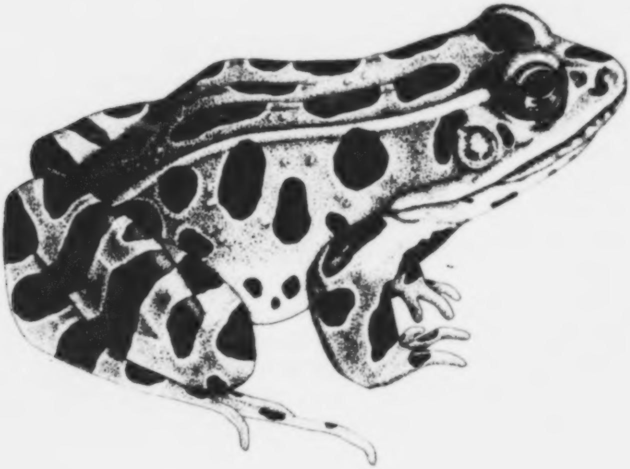
Northern Leopard Frog *Rana pipiens*

Other Names: Meadow Frog, Grass Frog, Leopard Frog.

The Northern Leopard Frog was once considered part of a single, extremely variable and wide-ranging species. It is now known that the Leopard Frog is actually a complex of at least seven different though closely related species in North America. The northernmost of these occurs naturally in British Columbia. Despite being one of the most widespread amphibians on the continent, the Northern Leopard Frog's range in British Columbia has shrunk drastically, making it, along with the Oregon Spotted Frog, one of the rarest amphibians in the province.

Description

The Northern Leopard Frog is either grass green or light brown overall with solid dark brown or olive spots on the back that have smooth, round edges and are sharply accentuated by dark edges and light outer halos. They can be in two or sometimes three rows down the back and vary both in size and number. Similar dark bars also occur on the legs. The belly is white and unmarked. A white stripe along the upper jaw extends to the shoulder. Prominent dorsolateral folds, generally lighter than the background colour of the



body (even golden), extend from the head to the groin without a break. Some have less prominent, non-glandular skin ridges along the back. The snout is pointed. The legs are long and the hind feet fully webbed. The body is slim and the skin smooth. Males have dark, swollen thumbs in the breeding season. Internally, the male Northern Leopard Frog has a vestigial oviduct; although it cannot be seen in a live animal, this feature helps distinguish this species from other leopard frogs. Males can grow up to 80 mm long and females up to 111 mm. See colour photograph 34.

The tadpoles are brown or grey with fine light or gold spots. The skin of the belly is creamy white or translucent so that the internal organs can be seen. The dorsal fin is colourless and may have fine, dark flecks. Tadpoles grow to about 90 mm in length.

Distinguishing Features: The large, distinct spots on the head, back, sides and legs that have dark edges accented by lighter halos; they can be scattered randomly or arrayed in two or three rows down the back. Other brownish, spotty frogs in British Columbia, such as the Red-legged Frog and the two species of spotted frogs, have faint, dark eye masks on their faces and smaller, more irregular spots on their bodies without the light halos.

Habits

The Northern Leopard Frog is a highly adaptable species that occurs in many types of wetland habitats. It is tolerant of cold climates and can venture far from standing water through grassy fields and meadows or along streams, especially on damp days in summer or fall. These frogs can be a major food source for garter snakes, Raccoons (*Procyon lotor*), herons and other predators. Besides leaping away and hiding under the mud of the pond bottom, their only apparent defensive behaviour is emitting a squealing distress call if seized. Judging by the variety of food items that have been found in their stomachs, Northern Leopard Frogs feed both day and night on small fishes as well as insects, spiders, snails and other small invertebrates. They are also known to cannibalize each other.

Northern Leopard Frogs hibernate on the bottom of a lake or stream, lying in a shallow depression in the sand or mud rather than burrowing into it. These sluggish, overwintering frogs make easy targets for predatory fish. A warm period in midwinter sometimes results in a frog's untimely emergence from hibernation.

Declines in Northern Leopard Frog populations have been reported in British Columbia and elsewhere in North America, but it is unclear what the specific causes are that underlie the dramatic range contractions. Loss and fragmentation of wetland habitat is a likely factor, although introduced fish and Bullfrogs elsewhere in North America may also take their toll.

Breeding

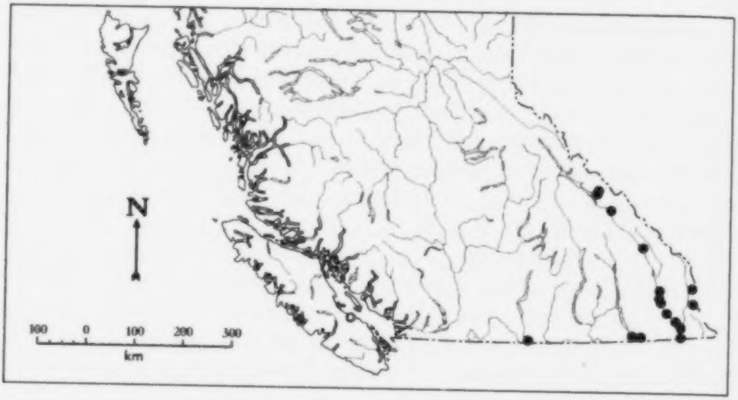
Northern Leopard Frogs generally breed during late April to May, not necessarily waiting for the ice on the ponds to melt completely. They migrate from their hibernation sites to small, open, well-vegetated breeding ponds and swamps. Males gather and call while they float on or just beneath the water's surface. Round, paired vocal sacs balloon out from the sides of the throat during a call. The dominant vocalization is a long, low, guttural rumble, something like "ira-ah-ah-ah-ah-ah-ah-ah-ah…", reminiscent of a small, puttering motorboat, a long snore, or a fart in a tight pair of chest waders. This call acts as an assembly and territorial spacing call. The frogs also have a large repertoire of grunts, hoots, groans, snores and pops that are associated with territorial disputes. Males aggressively search for receptive females and will grasp them in pectoral amplexus. They are indiscriminate and amorous in their pursuits, and have been observed trying to mate with other frog species and even a floating beer can. Whereas a female only mates once, males can mate several times.

A female lays a round or oval egg mass, about the size of a grapefruit, containing up to 7000 eggs. She attaches it to submerged sticks or dead vegetation, or lets it sit freely on the pond bottom or float near the surface, often close to many other egg masses. Eggs take from about 9 to 20 days to hatch, depending on water temperature. The tadpoles transform in midsummer into froglets 18 to 25 mm long. Northern Leopard Frogs take two or three years to reach sexual maturity.

Subspecies: None.

Range

All the species of leopard frogs cover most of North America and Central America. Northern Leopard Frogs range from eastern British Columbia, Washington, Oregon and California, across Canada and the northern United States to New England and the



Maritimes, occurring as far north as Labrador, Hudson Bay and Great Slave Lake. In British Columbia, Northern Leopard Frogs historically have had a limited distribution ranging from the Okanagan Valley to just north of Golden and down along the East Kootenays to the southern border of the province near Creston and Osoyoos. Native populations of Northern Leopard Frogs in British Columbia are now virtually extirpated, reduced to a small population in the Creston Valley Wildlife Management Area. A population has been re-introduced to Bummer's Flat Conservation Area between Wasa and Fort Steele, and an introduced population was found near Coombs on Vancouver Island in the 1970s, but its current status is unknown.

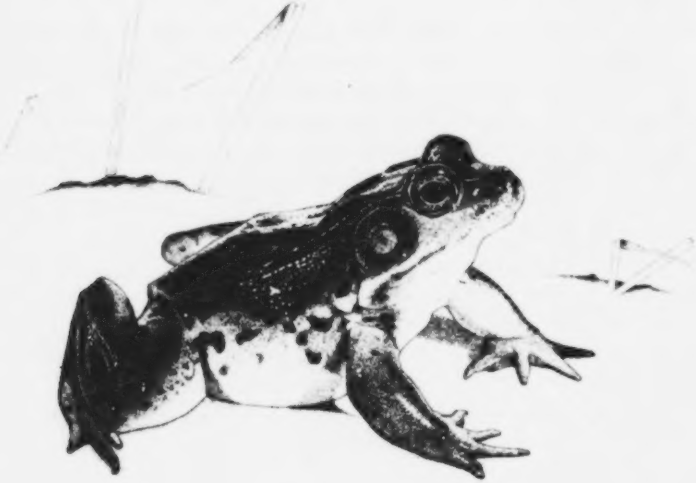
Selected References: Andelman and McAllister 1994, Emery et al. 1972, Freda and McDonald 1990, Leonard et al. 1999, McAllister et al. 1999, Wiese 1990.

Green Frog *Rana clamitans*

Like the Bullfrog, the Green Frog is an eastern species that is alien to British Columbia. It may have been introduced either as pet stock, fish bait or stock for frog farms, or its tadpoles may have been inadvertently included in shipments of goldfish.

Description

Green Frogs vary in greenish-brown shades from bronze to olive or even deep metallic green on the back, which is usually peppered with dark specks or small irregular marks. Most have a bright metallic green moustache on the upper jaw. The belly is white and sometimes has a few dark spots. Dark bars cross the legs. The head is fairly broad and the body robust. The tympanum is conspicuous: in females it is the same size as the eye, and in males it is larger than the eye. Dorsolateral folds extend about three-quarters of the way down each side of the back. Some frogs have a fold of skin curving behind the tympanum, particularly visible in juveniles. The skin is slightly rough and there may be wrinkles and tubercles on the sides but no warts. Males have bright yellow throats and swollen thumbs in the breeding season. Male Green Frogs can be 50 to 90 mm long; females are larger and can reach 100 mm. See colour photograph 35.



The tadpoles of the Green Frog are almost identical to those of the Bullfrog, except that they do not grow nearly as large; they rarely grow more than 90 mm long and have no trace of yellow. As the tadpoles grow larger, they develop a pointed snout and a long, oval body. Some large tadpoles have dark blotches and gold flecks on the back. The eyes are pale bronze.

Distinguishing Features: Green or olive-green with a light green moustache and white lower belly. The dorsolateral folds extend no more than three-quarters of the way down the sides of the back. No large, well-defined dark spots on the back.

Habits

The Green Frog is typically a pond-dwelling frog. It usually lives in lily ponds and shallow drainage ditches. More terrestrial than the Bullfrog, it forages in meadows and grassy fields during wet weather, and follows streams. During the day, Green Frogs can usually be found sunning alongside the banks of ditches or ponds or hiding beneath rocks by the water's edge. They are wary and are often difficult to approach. When frightened, they will squawk and leap frantically into the water to hide in the muddy bottom. Green Frogs have voracious appetites, consuming flying and crawling insects or any animal small enough to swallow; they also feed under water.

Breeding

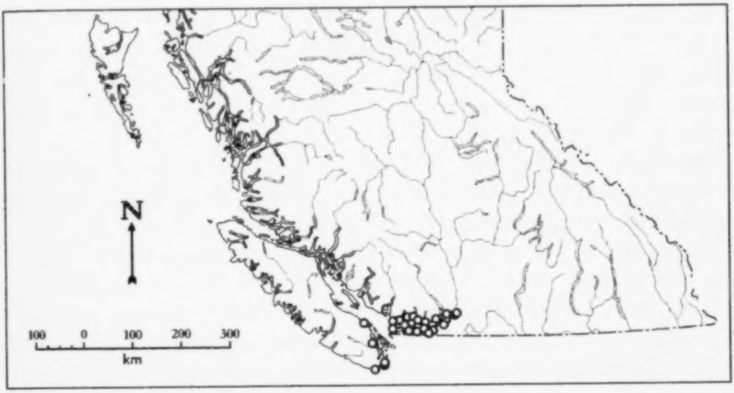
Green Frogs have a lengthy breeding season that continues throughout the late spring and early summer. Males establish breeding territories around preferred calling and egg-laying sites in the pond. Their basic call is a muffled explosion, a brief "k'tung", that serves as a territorial warning call. In territorial confrontations, neighbouring males emit this single note two or three times in succession. They also display their yellow throat as a threat. Occasionally, males determine dominance by wrestling each other while emitting soft growls and guttural rumbles. When a female enters a male's territory, he approaches and clasps her in pectoral amplexus. During the day, males call from sheltered positions along the shore of the pond. Their vocal sacs are internal, but sound also radiates from their tympanums (see page 30).

Each female lays 1000 to 5000 eggs in large, loose floating masses at the water's surface amid aquatic vegetation. The tadpoles winter in the pond and transform the following summer into little frogs about 25 mm long. They mature in two to three years.

Subspecies: Of two subspecies, the Green Frog (*Rana clamitans melanota*) is the one that has been introduced into British Columbia.

Range

Green Frogs are native to eastern North America east of the Great Plains, from extreme eastern Manitoba, Ontario, Quebec and the Maritimes south to the Gulf of Mexico. In British Columbia, Green Frogs have been reported from Hope through the lower Fraser River valley to Richmond and southwestern Vancouver. They also have been located near Coombs on Vancouver Island, as well as sites in and around Victoria.



Selected References: Bee et al. 1999; Boice and Williams 1971; Holomuzuki 1998; Schroeder 1968; Wells 1977, 1978.

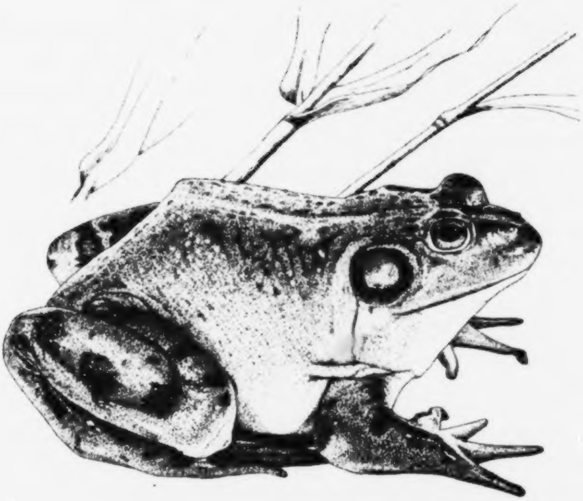
Bullfrog *Rana catesbeiana*

The Bullfrog is the largest frog in North America. It has been widely introduced as stock for many unsuccessful frog farms outside of its native range in eastern North America where, ironically, it is in decline. Its widespread introduction has led to scattered feral populations established throughout western North America, the Caribbean Islands, and even in Hawaii, Japan, England and Italy. Bullfrogs are now well-established in British Columbia and expanding their range on Vancouver Island and the lower Fraser River valley, where they have become predators of several native animals, including fishes, other amphibians and snakes.

Description

This large, robust frog is green, brownish green or olive on the back, often peppered with tiny, black specks or mottled with irregular, diffuse dusky patches; the dusky areas can extend onto the belly. The belly is white but often mottled with grey. The undersides of the chin and legs can be tinged with yellow, which is not vivid, except on the throat of adult males. Bullfrogs have neither an upper jaw stripe nor an obvious light moustache. The head is broad and the tympanum is conspicuous. A prominent fold of skin bends around the tympanum from the corner of the eye to the shoulder. There are no dorsolateral folds. The skin of the back can be granular but it has no warts or large tubercles. A sacral hump in the back is usually prominent. Most females have tympanums of the same diameter as the eye, but males have larger tympanums. Males in breeding condition also have enlarged thumbs and bright yellow throats. Male Bullfrogs can measure 80 to 180 mm in length; females are larger, sometimes exceeding 200 mm. See colour photograph 36.

Bullfrog tadpoles are similar in form to the tadpoles of Red-legged and Green frogs. They are green with light and dark speckles on their backs and narrow-set eyes on the tops of their heads, and tend to be more yellowish underneath than other tadpoles. Bullfrog tadpoles can be difficult to distinguish from Green Frog tadpoles, in particular, although they are much larger than any other tadpole found in British Columbia, especially when they have grown to near maximum tadpole size. Their heads can be larger than oversized marbles, and they can reach 135 mm long.

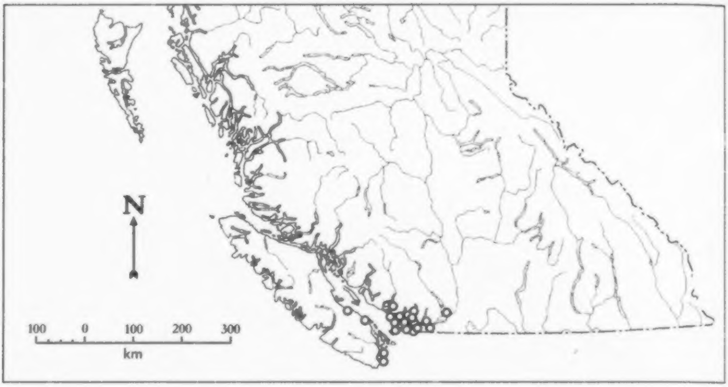


Distinguishing Features: Large and green or olive-brown. The conspicuous tympanum. Instead of dorsolateral skin folds, it has a prominent fold on each side of the head running from the eye around and behind the ear.

Habits

Bullfrogs are mostly aquatic and rarely leave the immediate vicinity of the weedy, heavily vegetated permanent ponds and lakes. They can also live in smaller, muddy ponds and ditches. They are extremely wary during the day and will rarely allow anyone to approach within a few metres. When frightened, juveniles sitting on a bank will leap into the water, barking "nyurp!", and disappear into the bottom mud. They are easier to approach at night with the aid of a bright light to dazzle them. Sometimes they will go limp and play dead when caught, then suddenly recover and leap away when they get the chance.

Although insects are a Bullfrog's usual fare when young, an adult Bullfrog is a voracious predator and will eat just about anything that it can stuff into its prodigious mouth. This includes young birds, mice, fishes, smaller Bullfrogs, and even small garter snakes and turtles.



Breeding

The Bullfrog has a prolonged breeding season that begins in late spring and extends through most of the summer. Adult males are territorial and will float, inflated, on the surface of the water while they call and show off their bright yellow throats to rivals. Calling territorial males attempt to seize any tempting females that venture into their territories and sidle up to them while they fend off intruding males with bluffs and wrestling matches. The loud call is an unmistakable deep bass snore that has been described as "jug o'rum" or "br-wum, bwum, bwum". In a typical bullfrog chorus, one male starts calling and rivals answer immediately, beginning the cacophony; then they fall silent for a time before another male announces his presence and receives another raucous response. As with the Green Frog, the vocal sac is internal, but male Bullfrogs also use their enlarged tympanums as loudspeakers to help broadcast calls. Non-calling males often lie low in a good territory and try to intercept females. Amplexus is pectoral.

Females lay 12,000 to 20,000 eggs in large, floating masses. The eggs hatch in 4 to 20 days, depending on water temperature, and tadpoles spend at least two years in the pond, hibernating through the winters in the bottom mud before they transform. Newly transformed froglets are about 40 mm long. Bullfrogs reach maturity in three to five years.

Subspecies: None.

Range

Bullfrogs are native to North America east of the Great Plains from southern Ontario and Quebec to the Gulf of Mexico. They have been introduced in scattered populations throughout western North America and elsewhere. In British Columbia, they occur in the lower Fraser River valley from Vancouver to Hope and on Vancouver Island from Victoria to Parksville.

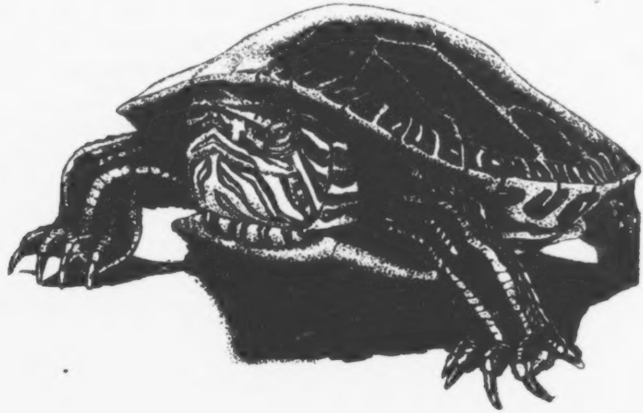
Selected References: Camargo et al. 1999, Collins 1979, Davis 1987, Green 1978, Hayes and Jennings 1986, Howard 1978.

REPTILES

Turtles

The two major groups of turtles – the suborders Cryptodira and Pleurodira – are most easily distinguished by the manner in which the head is retracted into the shell. The Cryptodires make a vertical S-bend in the neck when withdrawing their heads directly into the shell. The Pleurodires (also called side-neck turtles) withdraw their heads by bending the neck laterally. Cryptodires occur virtually wherever turtles are found; all North American turtles belong to this group. Pleurodires are restricted to the tropics and subtropics.

The body plan of turtles has not changed appreciably for approximately 200 million years. Turtles cannot be confused with any other kind of animal because of their peculiar bony shell. The shell consists of an upper domed carapace, a lower plastron and a bridge joining the two on each side of the body. It is made of bony plates covered by epidermal scutes (laminae), which are the coloured, visible parts of the shell. The carapace is derived from the ribs and vertebrae, and is combined with dermal bone that develops within the skin. The plastron is a combination of ribs and dermal bone. The margins of the bony plates and the laminae overlap. In many species of turtles, rings roughly similar to the annual growth rings of trees appear on the outer margins of the laminae during growth. Several factors influence the appearance of these



rings so that counting them is not necessarily a reliable means of determining the age of a turtle. Turtles also have various scutes on the head that are named in a similar manner to those of lizards and snakes.

The shell is protective. Many turtles have partial or complete hinges on the plastron, and four species of African tortoise (*Kinixys*) have a hinge on the carapace. Hinges allow the turtle to close its shell after drawing in its head, legs and tail. Only the American box turtles (*Terrapene*) can close their shell completely, because they have hinges on the front and back of the plastron.

The protective shell imposes some limitations on turtles. The carapace is partly composed of the turtle's ribs, which places both of the limb girdles inside the ribcage. This is unlike any other vertebrate, whose limb girdles are outside and free of the ribs. Turtles come by this odd arrangement through some complicated changes to usual vertebrate embryological development. Mammals and other reptiles breathe by contracting and expanding the thorax with muscles to draw air in to the lungs and push it out. But this is not possible for an animal contained in a rigid shell. Instead, turtles use their abdominal muscles to squeeze the internal organs and change the pressure in the body cavity, thereby allowing the lungs to fill with air. Because some of the muscles involved in breathing are located near the base of the legs, breathing movements can be seen in slight movements of the legs.

The shell restricts the length of a turtle's legs and prevents any bending of the body. Most terrestrial turtles (tortoises) have heavy shells, and tend to be slow and ponderous for their size. But some turtles have evolved a smaller shell, making them more mobile:

most sea turtles have a much smaller plastron than other turtles, and the largest, the Leatherback Sea Turtle, has much less dermal bone in its shell and no laminae, giving the shell a soft leathery appearance. The freshwater soft-shell turtles show similar structural reductions to the shell, possibly as a means of increasing camouflage on muddy river bottoms. Turtles with smaller shells cannot withdraw their heads and legs completely to make full use of the shell's protective potential. Such turtles, like soft-shell turtles and the Snapping Turtle (*Chelydra serpentina*), compensate for this with their large size or by being pugnacious when threatened.

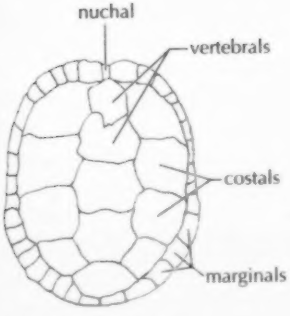
Turtles can be herbivores, carnivores or omnivores. They have no teeth, but use their horny beak to bite into food. They also sometimes use their feet to help them break up large food items.

Many aquatic turtles can remain under water for long periods of time because of their so-called pharyngeal and cloacal "gills". These structures are not true gills, but highly vascularized areas of the walls of the pharynx or cloaca, through which some gas exchange takes place between the water and the circulatory system. This kind of gas exchange is possible because ectotherms, such as turtles, do not have high oxygen requirements. In addition, turtles have a well-developed capacity for anaerobic metabolism.

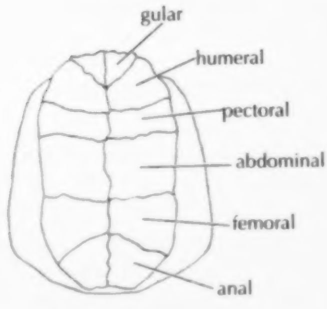
Despite being adapted to life in water, many aquatic turtles make frequent forays overland. All turtles are ultimately tied to the land for laying eggs because they are all oviparous.

Neither of the two species of marine turtles observed off the coast of British Columbia breed here; both mate and lay their eggs in tropical or subtropical areas. Two other species, the Olive Ridley (*Lepidochelys olivacea*) and the Loggerhead (*Caretta caretta*), have not been recorded in our waters, but likely occur here sporadically, because specimens have been recorded in Washington and Alaska.

Selected References: Bjorndal 1995, Ernst and Barbour 1989, Ernst et al. 2000, Klemens 2000.



dorsal view (carapace)



ventral view (plastron)

Key to the Turtles of British Columbia

1a. Forelimbs in the form of elongated flippers with one claw at most; lives in marine habitat; can be up to two metres in length; head and limbs not retractile .2

1b. Forelimbs with claws; almost always in freshwater habitat; shell no more than 25 cm long; head and limbs retractile 3

2a. Leathery shell and skin with no scutes; no claws on forelimbs; prominent longitudinal ridges on the carapace . . . . .Leatherback Sea Turtle (*Dermochelys coriacea*)

2b. Carapace with laminae; large scutes on head and tail; one claw on each forelimb . . . . .Green Turtle (*Chelonia mydas*)

3a. Dull brown or blackish, with irregular black or brown markings . . . . .Western Pond Turtle (*Clemmys marmorata*)

3b. Yellow stripes on head and limbs. 4

4a. Carapace black or olive brown; plastron bright red with large black blotch in centre; head and limbs black or olive with bright yellow markings . . . . . .Painted Turtle (*Chrysemys picta*)

4b. Carapace green (dark in larger specimens); plastron yellow with large black blotches; head and limbs green with yellow stripes; prominent red stripe on side of head . . . . .Pond Slider (*Trachemys scripta*)*

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* Introduced (see Introduced and Other Species, page 230).

FAMILY TESTUDINIDAE POND TURTLES

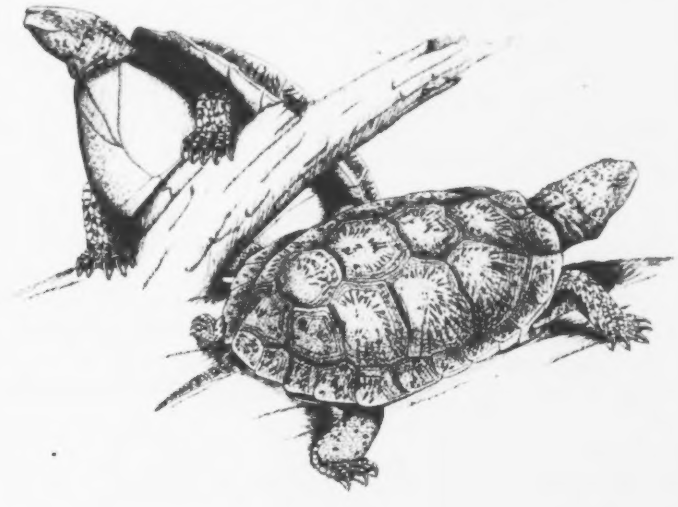
Western Pond Turtle *Clemmys marmorata*

Other Names: Pacific Pond Turtle; *Actinemys marmorata, Emys marmorata.*

The Western Pond Turtle is now considered extirpated in British Columbia, having been collected only twice (in 1933 and 1936) and last reported seen in 1966. It is unclear whether this species ever occurred naturally in the province, although a natural population did occur in the nearby Puget Sound area of Washington. If people introduced pond turtles to British Columbia, they most likely brought them here for food early in the 19th or early 20th century. The two records could be of turtles that escaped after being imported from the south. In any case, all of our knowledge of this turtle is based on studies done elsewhere. Taxonomists are currently debating the appropriate genus for this species.

Description

The Western Pond Turtle's carapace is low, smooth and longer than its width; hatchlings and young turtles have a rounder carapace with a mid-dorsal longitudinal keel and concentric ridges on each



lamina. The plastron is also smooth and fairly flat (more concave in males). The adult carapace is yellowish, olive-brown or sometimes blackish; sometimes a pattern of black or brown dashes and spots radiates from the growth centre of each lamina, but this pattern is often absent; the carapace length is 135 to 140 mm. The plastron is yellowish with irregular black or brown markings, though they are sometimes absent. The head, tail and limbs are yellowish, and the head can have dark brown or black spots and flecks. The scutes on the limbs are large, especially on the forelegs, with irregular brown markings. The hind feet are fairly well webbed. There are irregular brown markings on the tail. The claws are long and slender.

Distinguishing Features: Small and plain-looking, without the bright colours characteristic of the native Painted Turtle and the introduced Pond Slider.

Habits

The Western Pond Turtle is aquatic and usually found in quiet ponds, marshes or streams with muddy bottoms and emergent aquatic vegetation. It is occasionally found in brackish water and has even been seen entering the ocean. It is most often observed basking on logs or other objects at the surface of the water, but also moves about on land at times. For example, these turtles respond to drought conditions by either aestivating in mud or moving overland to ponds that still have water. They usually hibernate on land. Females must lay eggs on land.

This species is omnivorous, feeding mainly on aquatic plants and animals, and sometimes carrion. The Western Pond Turtle must swallow its food under water, using changes in the volume of the mouth cavity to draw in water and food. An aquatic turtle's small tongue may not allow it to move the food easily to the back of its mouth unless it is under water.

Observations of basking turtles have revealed that this is one of few species that demonstrates aggressive behaviour between individuals. Consequently, basking pond turtles do not stack up on one another as Painted Turtles do, but space themselves apart. Aggressive displays usually consist of stretching the neck and opening the mouth to reveal the vivid yellow and pink of the inside in contrast to the otherwise dull background colour. Occasionally, aggression goes so far as to include biting or ramming. It usually ends when one of the turtles withdraws its head, moves away, or is knocked off the basking site.

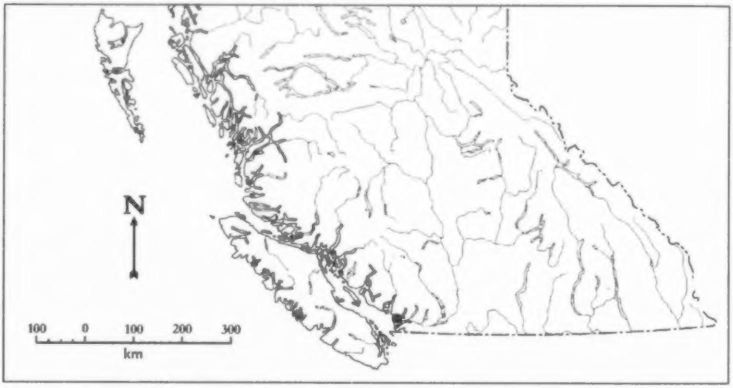
Breeding

Mating occurs in spring; eggs are laid in June or early July and hatch in late summer or early autumn. Females sometimes crawl 100 metres or more away from water to lay their eggs. She deposits a clutch of 3 to 11 eggs in a cavity excavated in soft soil. The eggs are hard-shelled and elliptical, 33 to 43.5 mm long. The young have a carapace length of about 25 mm.

Subspecies: Two are known: the Northern Western Pond Turtle (*Clemmys marmorata marmorata*) is the one recorded in British Columbia.

Range

The Western Pond Turtle occurs in Oregon, California and Baja California, with isolated populations in Washington and western Nevada. In British Columbia, specimens have been taken only from the Greater Vancouver area.



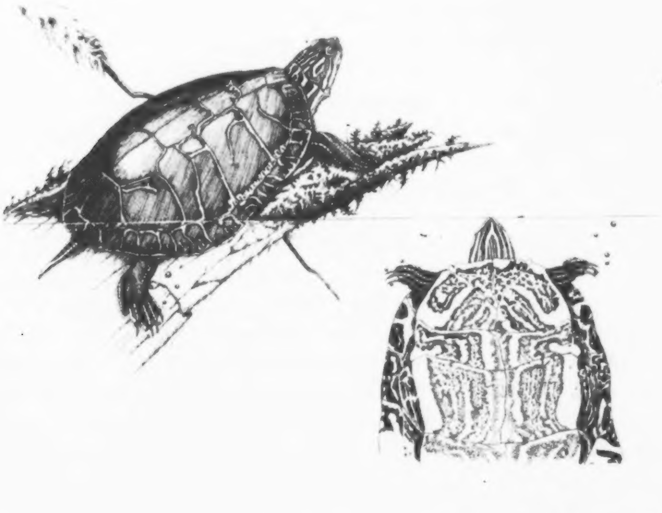
Selected References: Bury 1986, Ernst and Barbour 1989, Feldman and Parham 2002, Reese and Welsh 1998.

Painted Turtle *Chrysemys picta*

The Painted Turtle is one of the most widely distributed turtles in North America and occurs across southern Canada. The subspecies that inhabits British Columbia is the largest one. These animals are usually seen basking on logs and shorelines of lakes and ponds on sunny days.

Description

The Painted Turtle's carapace is low, smooth and longer than its width; hatchlings have a rounder carapace with a mid-dorsal longitudinal keel. The plastron is smooth and fairly flat (more concave in males). The carapace of adults can reach 200 to 250 mm in length, depending on location; females are usually larger than males. The carapace is black, brown or olive, sometimes with a light-yellow reticulated pattern or a faint mid-dorsal line running lengthwise. The marginal scutes are usually marked with yellow at the upper edges and red underneath. The plastron is bright red with a large black central blotch that branches out along the scute margins. The bridge has reddish markings. The head, tail and limbs are olive-green or blackish, with yellow lines on the head and tail, and small yellow spots on the limbs. The hind feet are well webbed. Males have long claws on their forefeet. See colour photographs 38 and 39.



Distinguishing Features: *The dark carapace, yellow stripes on the head and tail, and bright-red plastron with a dark blotch in the centre.*

Habits

Although the Painted Turtle is common in parts of British Columbia, it has been studied infrequently here and much of what we know about it is based on studies of Painted Turtles in other parts of North America, particularly the northeastern United States. It is an aquatic species found in ponds, lakes and streams with muddy bottoms, slow-moving water, and emergent aquatic vegetation. It can be very common in some parts of its range, sometimes in densities of 500 or more per hectare; but densities this great have not been recorded in British Columbia. This turtle feeds, mates, sleeps and does most other activities in water, but commonly travels several hundred metres on land. Its most conspicuous terrestrial activities are nest-digging and egg-laying by females. Painted Turtles usually hibernate at the bottom of a pond, but have occasionally been seen swimming under the ice, especially in spring.

This species is generally active during daylight, although nest-digging and egg-laying most often take place in the early morning and late evening, partly in darkness. Painted Turtles are conspicuous on warm, sunny days when basking in large groups on logs, mudbanks and other objects above water. Individuals show no aggression at such times, and turtles often pile on top of one another until they are two or three deep. Basking is an important part of thermoregulatory behaviour – Painted Turtles can easily adjust their body temperatures in summer by moving into and out of the water. They can bask for a couple of hours at a time, but the duration is related to air temperature and other weather conditions. Turtles often maximize their exposure to the sun by spreading their legs and basking completely out of the water.

As is true for reptiles in general, temperature is an important factor governing many aspects of the Painted Turtle's life history. The length of the active season and hibernating period are governed by water temperature, as is the onset of breeding activity. Spring movements correlate with warm, sunny weather. Males become active earlier than females in spring. In a given active season, temperature determines when feeding and other activities occur. Consequently, growth rate is also a function of temperature.

Adult Painted Turtles are omnivorous. Juveniles are almost completely carnivorous, feeding mainly on small invertebrates. As they grow, they prey on larger animals, such as frogs and fishes, and begin to eat more vegetation, which is less nutritious than meat but easier to obtain; adults also commonly scavenge. Like other aquatic turtles, the Painted Turtle swallows its food under water, using suction rather than its small tongue to move the food in its mouth back to its throat (see page 165). Young turtles grow rapidly, but the growth rate decreases as the turtle approaches sexual maturity and is slow from then on.

Breeding

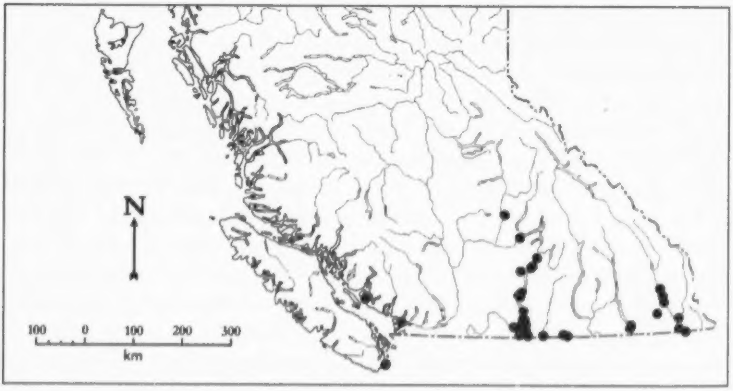
In British Columbia, male Painted Turtles usually mature at the age of three or four years and females at seven or eight years. Courtship and mating usually take place in spring when the water begins to warm, although Painted Turtles also sometimes mate in the fall. These turtles usually mate in shallow water. Mating is the only activity in which they get aggressive with each other, and usually consists of a larger male driving away smaller competitors. In courtship, several male turtles may chase a female. When one male catches up to her, he swims in front and faces her, with his front legs outstretched by the sides of his head, palms outward. The male then uses his long claws to tickle or stroke the female's head. Between stroking bouts, he swims away, appearing to entice the female to follow him. Sometimes she strokes the male's head and, occasionally, a female initiates courtship (and drives away other females). Courtship generally lasts 5 to 15 minutes, after which the female sinks to the bottom of the pond, followed by the male, who then mounts her. Copulation always takes place under water.

Painted Turtles generally begin nesting in late June. Females make their nests on land, usually within 150 metres of water, in fields or pastures, on beaches or roadsides, or in any situations where nest holes can be dug. They usually dig them on slopes with a southern exposure and good drainage. The turtle often urinates on the chosen site before she begins to dig, and periodically during the excavation process; presumably, wetting the soil makes it easier to dig. The finished nest hole is flask-shaped. The turtle deposits 6 to 22 eggs into the hole, each one up to 23 x 39 mm, then refills it. Some females pack down the soil by passing over the site several times, and many cover the nest with debris such as leaves and twigs. The egg stage is one of the most vulnerable phases of a turtle's life, because egg predators, especially mammals, are abundant. Mortality of both eggs and young turtles is much greater than that of adults. The young, upon hatching in late summer, do not immediately emerge from the nest, but overwinter there and emerge the following spring. Hatchlings have a carapace length of about 25 mm.

Subspecies: The Western Painted Turtle (*Chrysemys picta bellii*) is the largest of four known subspecies and the only one occurring in British Columbia.

Range

Painted Turtles occur from the Atlantic to Pacific coasts in southern Canada and the northern United States. They are widespread in the southeast, along the Mississippi River and on the northern plains of the United States, but absent from the Great Basin, the southwest and the Pacific coast. In British Columbia, the Painted Turtle is restricted to the southern part of the province. It is most abundant in the Okanagan Valley and the Kootenay region, but also occurs on the mainland coast, on Vancouver Island and on some Gulf Islands. There is some question about the status of coastal populations of Painted Turtles. Vancouver Island populations, for example, are possibly the result of introductions of former pets. In any case, the species does not seem to be abundant in coastal localities. A northern interior record from Vanderhoof was also probably an escaped pet.



Selected References: Blood and Macartney 1998, Ernst et al. 2000, St. Clair and Gregory 1990, St. Clair et al. 1994.

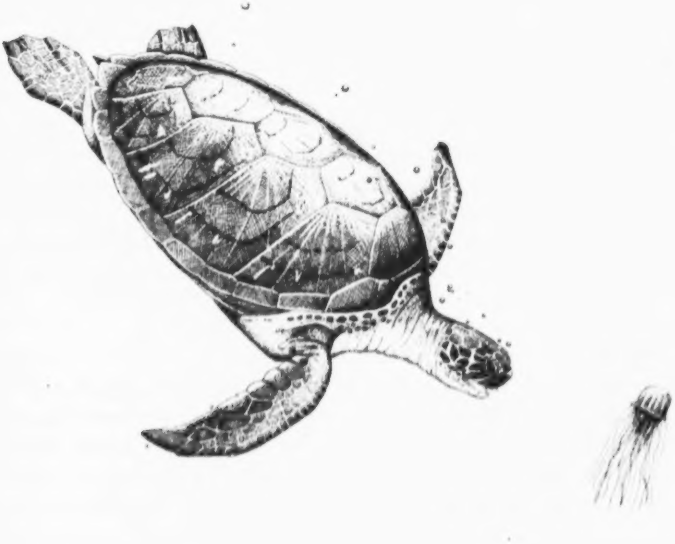
FAMILY CHELONIIDAE SEA TURTLES

Green Turtle *Chelonia mydas*

The Green Turtle is a member of one of two families of large marine turtles that range mainly in tropical and subtropical waters. A few species, such as this one, sometimes move into temperate-zone waters in summer or in El Niño years. Only nine occurrences are known for the Green Turtle in British Columbian waters.

Description

The Green Turtle's carapace is smooth, with laminae and a serrated posterior margin; the anterior margin does not extend beyond the base of the forelimbs and neck. The adult carapace can reach 150 cm long, sometimes longer in males. The plastron is small relative to the carapace. The head, limbs and tail are covered with scutes. The limbs are paddle-shaped, especially the forelimbs, which form elongated flippers; each forelimb has a large, curved claw. Females have a short tail, but the males' tail is long and prehensile with a horny tip. The carapace is olive or brownish and the plastron pale yellow or white. The head, limbs and tail are olive-yellow. See colour photograph 40.



Distinguishing Features: A marine turtle with large flippers for forelimbs and scutes on the carapace.

Habits

The Green Turtle is mainly tropical and subtropical in distribution. No permanent populations occur in British Columbia and only three specimens have been recorded here since 1954; one live specimen was found on a beach and the other two were carcasses. Green Turtles are known to wander great distances in the sea, so these specimens may have been off course. This species tends to occur in shallow seas where vegetation is abundant, such as over the continental shelves. The adults feed mainly on vegetation such as macroalgae and sea grasses, although they may also eat jellyfish and other invertebrates. The young apparently feed on small invertebrates. Green Turtles are almost entirely aquatic and rarely emerge onto land except to lay eggs, although some (usually females) have been seen basking on the rocks of remote islands. But these turtles are more likely to bask by floating at the surface, where they sometimes also sleep. Males probably never leave the water. In the Gulf of California, Green Turtles hibernate in winter partially buried in the bottom sediments.

The major predators of adult Green Turtles are large carnivores such as sharks. Presumably the turtle's tendency to sleep under water under the protection of overhanging ledges is an anti-predator behaviour. Green Turtles and their eggs have been prized as food by humans for several hundred years and have been heavily exploited. Consequently, important conservation work has been done on this species and, as a result, our knowledge of its biology is fairly extensive, at least for the adults. Although eggs in the nest are subject to heavy predation, young turtles moving between the nest and the sea are also vulnerable. Many fall victim to a wide variety of predators, such as rats, gulls and crabs. What the survivors do after making it to the water is a major mystery. The biology of wild Green Turtles in their first year of life is almost completely unknown.

Breeding

Green Turtles do not breed in British Columbia. Their main breeding sites in the Americas are on the east coast of Costa Rica and some Caribbean Islands. This species also nests in Australia, certain islands in the Indian Ocean and various other places in the tropics. Rookeries (nesting areas) are always sandy beaches where nest digging is easy. Nesting beaches are usually used by large numbers of turtles. Human depredations have wiped many of the large rookeries around the world, because these turtles are particularly vulnerable when nesting.

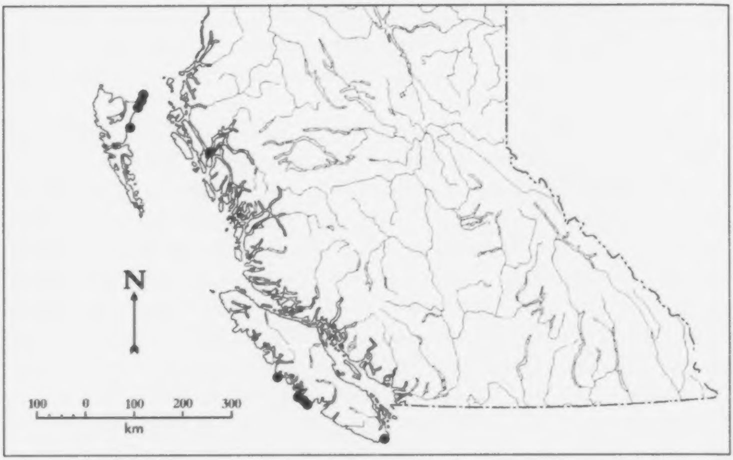
How individual turtles are able to home in on specific breeding areas over long distances in the sea remains one of the mysteries of Green Turtle biology. Mating takes place in shallow water just offshore, either at the surface or on the bottom, and peaks before egg-laying begins. Females and copulating pairs may be accompanied by several males, which presumably compete for mates. Courtship in Green Turtles is a strenuous activity, with the female ultimately determining whether or not mating actually occurs. Copulation can last for six hours. Males can copulate many times in a single breeding season, but females mate only once. From a single mating, though, a female usually has enough sperm to produce four or more clutches.

The female lays each clutch separately, one to two weeks apart. On each occasion, she emerges onto land, usually at night and at a high tide, to crawl laboriously up to a suitable nest site well above high tide. She groans and sighs, expelling air from her lungs with each movement of her massive body over the sand. Nest-digging can take several hours. Once the nest is dug, the female lays 100 to 150 spherical eggs, 35 to 58 mm in diameter. Then she refills the hole with sand and hides the nest by disturbing the sand around it. Finally, the female heads back to sea, having been on land, in some cases, most of the night. Breeding seasons for an individual turtle are apparently two or more years apart, the intervening time occupied by extensive movements through the ocean. The hatchlings (35 to 59 cm in carapace length) usually dig their way out of the nest at night, but sometimes wait until daylight before heading for the water.

Subspecies: Two are sometimes recognized: the subspecies recorded in British Columbia waters is the Pacific Green Turtle (*Chelonia mydas agassizi*).

Range

Totally marine and mainly tropical and subtropical, Green Turtles occur in the Atlantic, Pacific and Indian oceans. They are rare vagrants off the coast of British Columbia and occasionally become stranded on shore. A live specimen was found ashore at Ucluelet, Vancouver Island, in 1954.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Selected References: Hirth 1980, Ernst and Barbour 1989, McAlpine et al. 2002.

FAMILY DERMOCHELYIDAE

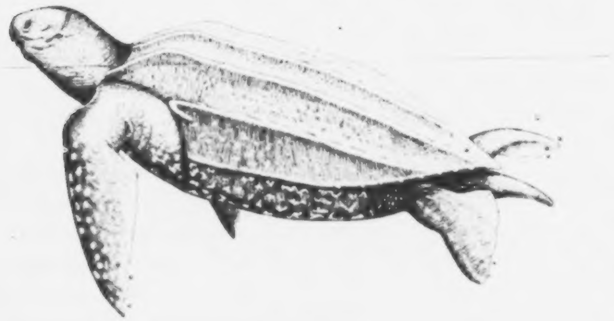
Leatherback Sea Turtle *Dermochelys coriacea*

Other Names: Leatherback, Leatherback Turtle.

The Leatherback Sea Turtle is the largest living turtle and the only member of its family. It is completely marine, and although mainly tropical and subtropical in its distribution, it ranges widely and is seen fairly often in temperate-zone waters.

Description

The Leatherback Sea Turtle's shell is narrow, long and low; it does not extend beyond the base of the neck and limbs. The carapace is up to 240 cm long, and this turtle can weigh up to 363 kg (rare specimens have reached up to 680 kg). The shell consists of polygonal dermal bones (not associated with the ribs and vertebrae) covered with leathery skin, but no scutes. The young are covered with small scutes, which are soon shed, and have a keeled, rudder-like tail. The carapace has seven prominent longitudinal ridges and the plastron five. The limbs are paddle-shaped and lack claws, with the forelimbs in the form of long flippers; the hind limbs are broadly connected to the tail by a web. The Leatherback's colour is uniformly black, bluish black or greenish black, and sometimes lightly spotted with yellow or white.



Distinguishing Features: Large sea turtle with flippers for forelimbs. Leathery skin on the carapace, with longitudinal ridges but no scutes.

Habits

The Leatherback Sea Turtle is totally marine and usually found far out to sea throughout the tropics and subtropics, though it returns to shore to lay eggs. It has been reported in British Columbia waters at least 17 times in the last 70 years, but does not permanently reside or breed in this area. Such occasional sightings are probably not surprising in view of the long-distance movements of this species. The Leatherback has been sighted further north and further south than any other marine turtle. Apparently, it produces heat endogenously by muscular activity and its large body size favours heat retention, so that its body temperature can be well above the water temperature and reach 25.5°C when the water temperature is 7.5°C. It may also seek shallower, warmer water in colder areas, enabling it to travel in Canada's Atlantic and Pacific waters during the warmer months of the year.

The Leatherback Sea Turtle is mainly carnivorous and has been seen in groups feeding on jellyfish, apparently a major food item. It emits loud cries when injured. The Leatherback is of some commercial importance in parts of the tropics where oil from the shell is used as a varnish. People eat the eggs, both for nourishment and as an aphrodisiac. Like all sea turtles, this species is in need of conservation measures. The Leatherback is an endangered species whose numbers are declining rapidly.

Breeding

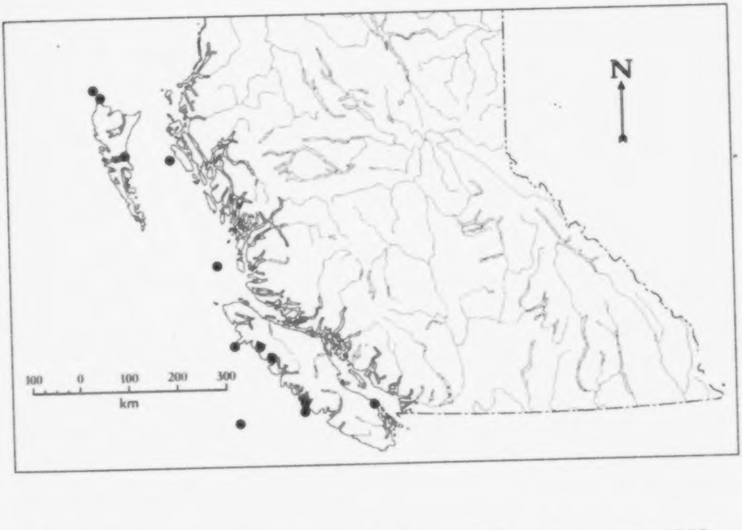
Only female Leatherback Sea Turtles emerge onto land, and only to lay eggs. The breeding behaviour of this turtle is much like that described for the Green Turtle (pages 172-73). Mating takes place offshore from the rookeries (nesting areas), which are sandy beaches where digging is easy. Several thousand females nest in a single season at large rookeries. Major Leatherback rookeries are in Malaya and French Guiana, with many others scattered throughout the tropics, including the Americas (e.g., Pacific coast of Costa Rica). They do not nest in British Columbia or nearby areas.

A females emerges onto a beach at night and laboriously crawls to her laying sites, groaning and sighing as she moves her massive body. She digs a nest hole with the rear flippers and lays 50 to 170 nearly spherical eggs, each 49 to 65 mm in diameter. A female can lay several clutches per breeding season, one every 8 to 12 days. Hatchlings have a carapace length of 58 to 63 mm.

Subspecies: Two are sometimes recognized, but only the Pacific Leatherback Sea Turtle (*Dermochelys coriacea schlegeli*) has been recorded in British Columbian waters.

Range

Apart from nesting periods, the Leatherback Sea Turtle is totally marine and mainly tropical and subtropical; nesting is confined to tropics. It occurs in the Atlantic, Pacific and Indian oceans. In the North Pacific, it reaches the Gulf of Alaska. In British Columbia, Leatherbacks have been reported in the Strait of Georgia, off the west coast of Vancouver Island and off the Queen Charlotte Islands.



Selected References: Ernst and Barbour 1989, Mrsovosky 1983, Spotila et al. 2000.

Lizards

Lizards comprise more than half (about 56 per cent) of living reptile species and they are the most ecologically diverse of present-day reptiles. Like other groups of reptiles, lizards are most abundant, widespread and diverse in the tropics and subtropics, reaching even remote islands in the Pacific Ocean.

The only environment that modern-day lizards have not invaded in great numbers is the sea. But a few species have adapted well to the ocean, such as the Marine Iguana *(Amblyrhynchus cristatus)* of the Galápagos Islands. Although based on land, the Marine Iguana forages in the ocean for seaweed, sometimes diving to 15 metres below the surface. It swims by undulating its body and tail laterally while keeping its limbs pressed closely to its sides.

As might be expected in such a diverse group, lizards range in size from the tiny gecko *Sphaerodactylus partheopion* of the British Virgins Islands, just 18 mm long, to the Komodo Dragon *(Varanus komodensis)*, a three-metre-long giant restricted to a small area in Indonesia. Lizards can be carnivores, omnivores or herbivores; most are insectivores, including the species that inhabit British Columbia. Many lizards have a kinetic skull; although the skull is not as flexible as that of a snake, many carnivorous lizards can swallow relatively large prey.

Only two species of lizards are known to be venomous, both belonging to the genus *Heloderma* of the southwestern United States and Mexico. These lizards deliver venom to prey via grooved fangs in the lower jaw (unlike snakes, whose fangs are in the upper jaw). No ducts connect the venom glands in the lower jaw to the teeth. The venom seeps from the glands and flows along simple grooves in the fangs, so wasting much of the venom. Because of its ineffcient venom delivery apparatus, the Gila Monster *(Heloderma suspectum)* bites with a "bulldog-grip" and chewing action to envenomate its prey. The venom is mainly neurotoxic, but it is not known how important it is as a means of obtaining prey. The upper teeth also have grooves.

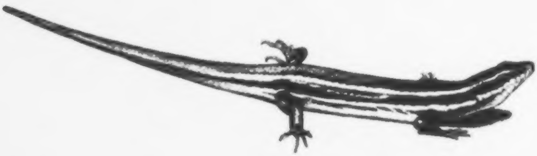
The lizard tongue varies greatly from species to species. Most lizards have a forked or lobed tongue and use it in the same manner as a snake, in conjunction with Jacobson's organ as a sensor of the chemical environment. A monitor lizard's tongue is very much like a snake's, darting in and out frequently. In other lizards, the tongue can be broad, flat, and either forked or only slightly bi-lobed at the tip. The bi-lobed tongue can be pink and fleshy, much like the tongue of a mammal, and used more to manipulate food inside the mouth than to sense the environment. The Northern Alligator Lizard and Western Skink of British Columbia have a broad pink tongue with well-defined lobes at the tip. Both species flick out the tongue frequently during periods of activity. The Old World chameleons, which are arboreal but slow moving, have evolved an elongated, retractile, sticky tongue that can be shot out at high speed to catch insect prey.

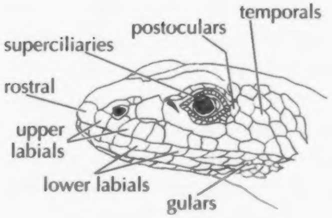
Most kinds of lizards have a long tail. For some it is prehensile and helps them climb and for others it simply balances the body as the lizard walks or run on the ground. Some species, such as iguanas, monitors and tegus, wield their tail as a defensive weapon, while others can cast it off as a decoy for predators. Some lizards store fat in their tail.

Early in their evolutionary history, lizards probably gave rise to snakes. The two groups share many features, including aspects of their reproductive biology. Males have paired copulatory organs, called hemipenes, in the base of the tail (only one hemipenis is used at a time) and females are either oviparous or viviparous, depending on the species. Several species of lizards (and at least one of snakes) are female-only and parthenogenetic, a condition unknown in other reptiles.

Some lizards, especially those with small or no limbs, can shed their skins in one piece as do snakes, although most lizards moult their skin in several pieces. Some lizards eat the pieces of shed skin. Many species of lizards have an armour of dermal bones associated with their scales. Scale patterns of lizards also tend to be highly variable and quite different from those of snakes. Unlike snakes, most lizards have well-developed ears, with the hole or tympanum usually visible on the side of the head.

Selected References: Huey et al. 1983, Mattison 1992, Pianka and Vitt 2003, Smith 1946, Vitt and Pianka 1994.

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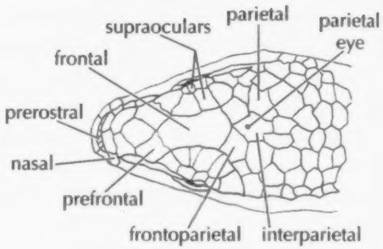
lower labials
gulars

lateral view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dorsal view

Key to the Lizards of British Columbia

1a. Body short, squat and flat; tail much shorter than body length; spiny scutes on body and back of head .... Pigmy Short-horned Lizard (*Phrynosoma douglasii*)

1b. Body long and slender with pointed snout; tail longer than body, when intact; no spines on body 2

2a. Dull brown with dark blotches (small specimens may be copper coloured); prominent fold of skin along lower side of body (scutes in area of fold smaller than those on back; noticeable when sides expanded); large scales on back and belly separated by smaller mid-lateral scales .... Northern Alligator Lizard (*Elgaria coerulea*)

2b. Body marked with prominent stripes, dark spots or reticulations 3

3a. Alternating, longitudinal stripes of brown and white along dorsal surface; small specimens may have blue tails; shiny appearance; scales around abdomen nearly equal in size .... Western Skink (*Eumeces skiltonianus*)

3b. Prominent black markings on body, including longitudinal stripes; not shiny; large scales on belly and bead-like scales on back and sides .... Common Wall Lizard (*Podarcis muralis*)

FAMILY PHRYNOSOMATIDAE

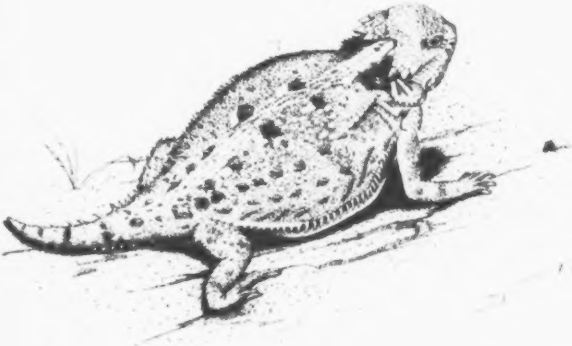
Pigmy Short-horned Lizard
Phrynosoma douglasii

Other Names: Pygmy Short-horned Lizard, Northwestern Short-horned Lizard, Horned Toad, Pigmy Horned Lizard.

Although horned lizards are widely distributed in western North America, only two species occur in Canada. Of these, only the Pigmy Horned Lizard has been recorded in British Columbia, where it is now considered extirpated. The Pigmy Short-horned Lizard is one of a complex of species, formerly considered to be a single, variable species, that has undergone recent taxonomic revision. A related member of this group occurs in southeastern Alberta and southwestern Saskatchewan. All that we know about the biology of Pigmy Short-horned Lizards has been gleaned from populations in the adjacent United States, where the species is fairly common.

Description

The Pigmy Short-horned Lizard's body is short, squat and flat, and up to about 65 mm long from snout to vent, with the tail about half as long again; females are slightly larger than males. The head is short and approximately as broad as its length; the legs are short.



The back and sides are covered with spiny scales, with a single prominent row of spiny scales forming a fringe of spines along each side between the legs. Short, stout horns protrude from the back of the head. Males have enlarged postanal plates (scutes) on the underside, and usually a broader tail base than females. The back is brown, reddish, tan or grey, with two rows of dark blotches on either side of the midline and a single pair of dark blotches on the neck. The ventral surface is pale yellow or whitish. See colour photograph 41.

Distinguishing Features: Squat, rounded, short-tailed and spiny.

Habits

The only two known specimens of the Pigmy Short-horned Lizard for the province were collected near Osoyoos in 1910. The species is considered extirpated in British Columbia, especially after significant human disturbance of its habitats in the southern Okanagan Valley.

In the United States, the Pigmy Short-horned Lizard occurs in a variety of habitats from sagebrush deserts to light forests, and at a wide range of elevations. It is found most frequently in open habitats where the soil is loose and sandy, but also in rocky areas. It is cold-tolerant for a lizard, which accounts for its occurrence at high elevations and high latitudes. Like most horned lizards, this species is difficult to find because its colour and pattern tend to match the ground and most individuals lie almost motionless until closely approached. Horned lizards also bury themselves in sand.

These lizards are active in daylight, typically earlier in the morning and later in the evening than other lizards. They are "sit-and-wait" predators rather than active pursuers and are often found in the vicinity of ant nests. Ants are a major food of most horned lizards, but the Pigmy Short-horned Lizard feeds on a variety of insects and other small invertebrates.

The Pigmy Short-horned Lizard defends itself mainly by inflating its body and opening its mouth. Its spines discourage some predators. Other horned lizards squirt blood from the eye (see page 25), but this defensive behaviour has not been recorded for this species.

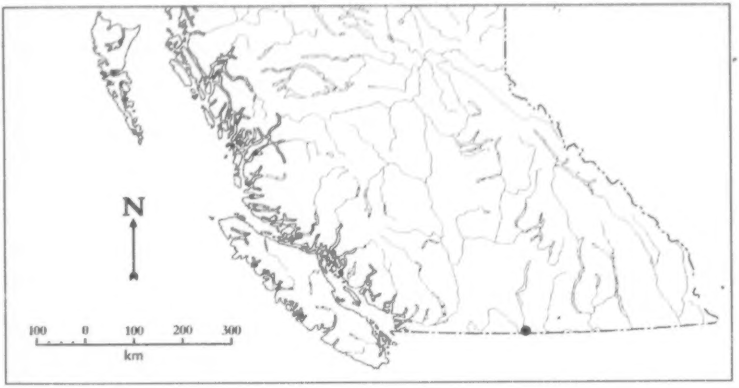
Breeding

Courtship and mating occur in spring. Pigmy Short-horned Lizards are live-bearing and produce broods of 3 to 15 young in late summer or early autumn. Newborns have a snout-vent length of about 22 mm.

Subspecies: None currently are recognized. The Pigmy Short-horned Lizard is one of five former subspecies of what was previously recognized as the Short-horned Lizard.

Range

Pigmy Short-horned Lizards are found from southern British Columbia through central and western Washington and Oregon, and all but the northeastern corner of Idaho. Its range barely extends into British Columbia, with only two records from the Osoyoos area in 1910. Although anecdotal sightings have been reported since then, none have been substantiated and the species is thus considered extirpated from Canada.



Selected References: Guyer and Linder 1985, Powell and Russell 1998, Zamudio et al. 1997.

FAMILY LACERTIDAE

Common Wall Lizard *Podarcis muralis*

Other Names: European Wall Lizard.

The Common Wall Lizard is the only introduced species of reptile known to have established a breeding population in British Columbia. A small number of Italian specimens released near Victoria in the early 1970s has multiplied dramatically. So far, these lizards have not spread far beyond their point of introduction. More rapid dispersal to other areas on Vancouver Island via human intervention should be discouraged.

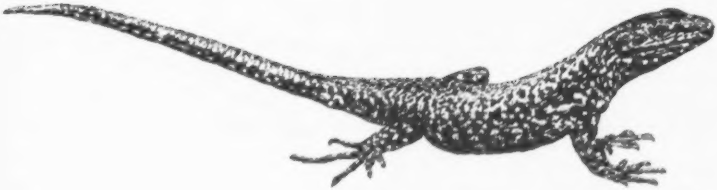
Description

The Common Wall Lizard's body is long and slender; specimens captured in British Columbia have measured up to 63 mm in snout-vent length, with an intact tail one and a half to two times as long. The belly scales are keeled. Common Wall Lizards exhibit highly variable colours and patterns: brownish or grey, sometimes with a green tinge, usually with a dark broken stripe down the middle of the back and black spots or a reticulated pattern on the sides. Some have minute, bead-like scales on the back. Some are spotted all over, but females are usually less spotted and have a dark dorsolateral stripe on each side. See colour photograph 42.

Distinguishing Features: Highly variable in pattern and colour, but most are strongly marked with black spots or reticulations, and some have tiny bead-like scales on the back. Markings on Northern Alligator Lizards are much less noticeable. Although some Common Wall Lizards have longitudinal stripes, like those of the Western Skink, these lizards are not shiny.

Habits

The Common Wall Lizard is a small, fast-moving lizard. Its name is derived from the ease with which it climbs walls, on which it often lives in Europe. It is essentially a ground-dwelling species in our area. In British Columbia, it seems to prefer open, exposed sites with cover objects such as rocks. It also seems to avoid heavily forested areas, which may limit its dispersal. Like our native



lizards, the Common Wall Lizard is often found hiding under cover, but it is more prone to basking in the open, relying on its speed for escape. If caught, it can readily autotomize its tail. Common Wall Lizards feed mainly on small invertebrates, but adults will also eat young lizards, at least in captivity. Males are aggressive towards one another and will fight, presumably over mates or territory. In British Columbia, the Common Wall Lizard co-occurs with the native Northern Alligator Lizard; it is a potential competitor and perhaps even a predator on smaller alligator lizards, but there is no evidence, so far, that the two species interact in this way.

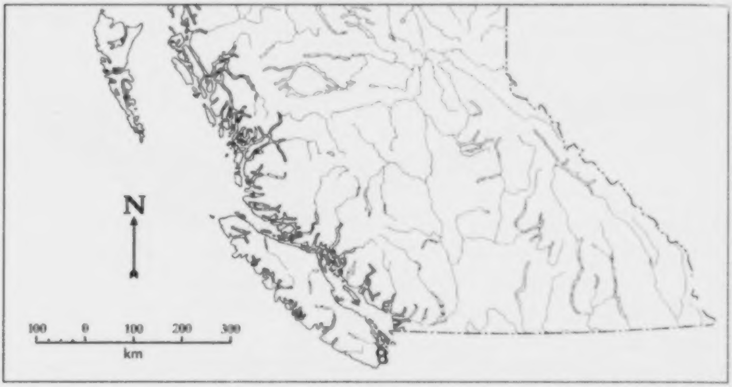
Breeding

Mating presumably occurs in spring. The Common Wall Lizard is an egg-laying species and, in the Victoria area, appears to be able to produce two clutches a year. Clutches range from three to eight eggs and are sometimes laid in communal nests.

Subspecies: The subspecific taxonomy of the Common Wall Lizard is a matter of some dispute, with recent estimates of number of subspecies varying from 8 to 18. The subspecies occurring in British Columbia is probably *Podarcis muralis maculiventris*.

Range

Middle and southern Europe to Turkey. In British Columbia, the Common Wall Lizard is confined to a relatively small area near Victoria on Vancouver Island, but it appears to be spreading from its original point of introduction, so its range will likely increase in future.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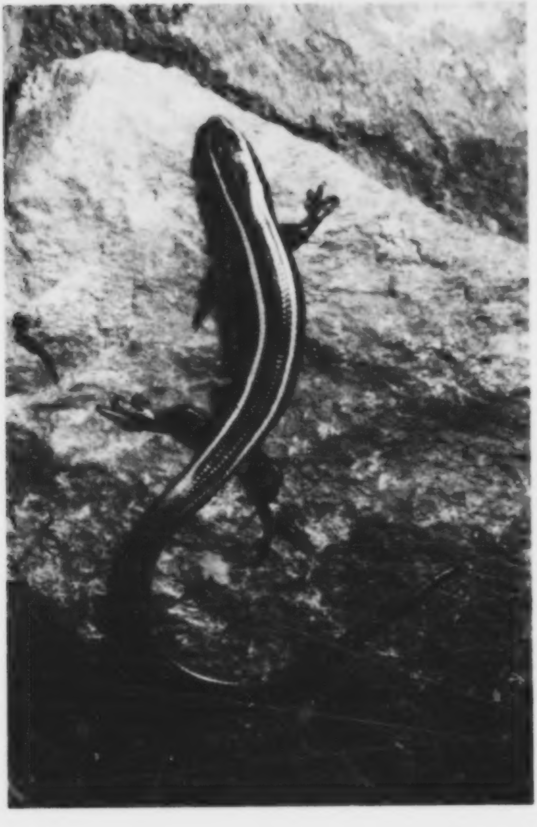
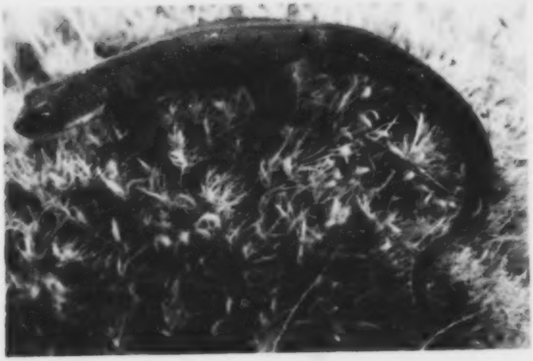
Selected References: Arnold and Ovenden 2002, Bertram 2004, Brown et al. 1995, Deichsel and Schweiger 2004, Kwiat and Gist 1987.

COLOUR PHOTOGRAPHS

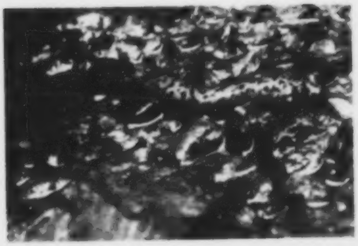


1. Western Skink (*Eumeces skiltonianus*) at the Creston Valley Wildlife Centre. ROBERT CANNINGS.

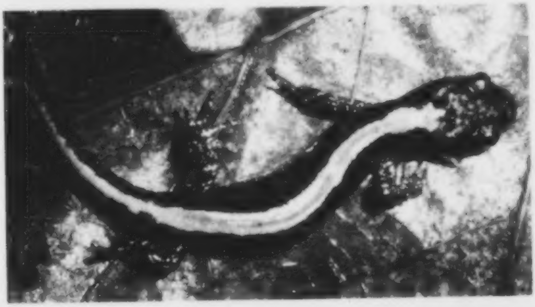


2. Rough-skinned Newt (*Taricha granulosa*) at Metchosin, near Victoria. GAVIN HANKE.

3. A neotenic Coastal Giant Salamander (*Dicamptodon tenebrosus*). BRENT MATSUDA.



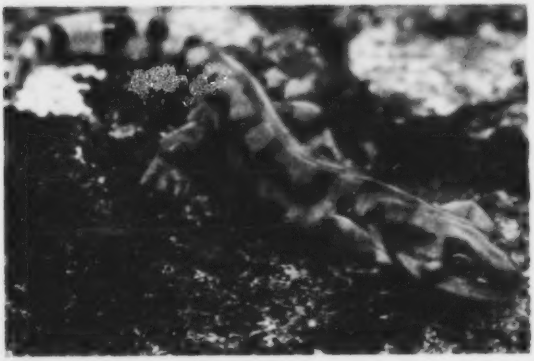
4. Coastal Giant Salamander in the Chilliwack River valley. BRENT MATSUDA.

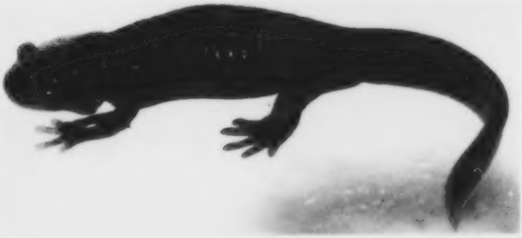


5. Long-toed Salamander (*Ambystoma macrodactylum*) adult at Saanich, Vancouver Island. VIRGIL HAWKES.

6. Long-toed Salamander larva. DAVID GREEN.

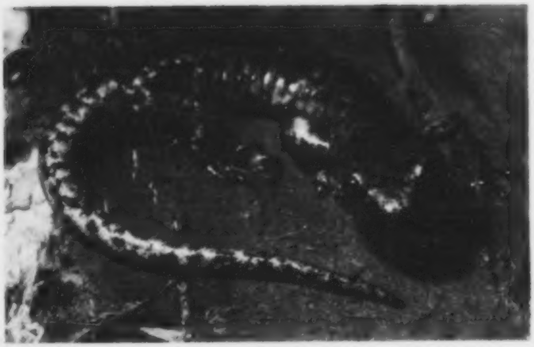
7. Tiger Salamander (*Ambystoma tigrinum*) near White Lake Park, Okanagan Valley. JARED HOBBS. (See also 10, below.)

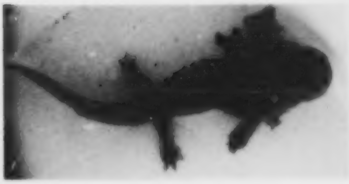




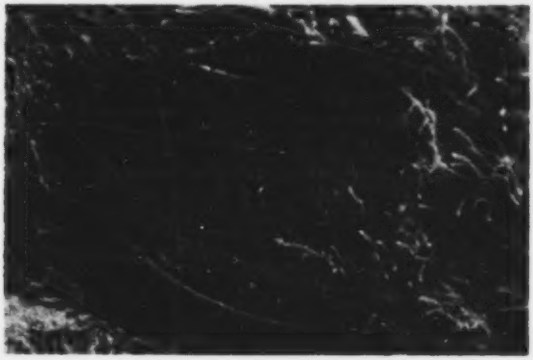
8. Northwestern Salamander (*Ambystoma gracile*) from Qualicum Beach, Vancouver Island. DAVID GREEN.

9. Wandering Salamander (*Aneides vagrans*) at Rosewall Creek, Vancouver Island. TED DAVIS.





10. Neotenic Tiger Salamander. BRENT MATSUDA.



11. Western Red-backed Salamander (*Plethodon vehiculum*) at Matheson Lake, near Victoria. GAVIN HANKE.

12. Coeur d'Alène Salamander (*Plethodon idahoensis*) near Galena Bay, Upper Arrow Lake. JARED HOBBS.

13 (above). Ensatina (*Ensatina eschscholtzii*) from near Victoria. DAVID GREEN.

14 (left). Ensatina in the Chilliwack River valley. BRENT MATSUDA.

15. Great Basin Spadefoot Toad (*Spea intermontana*) near Kamloops. KARL LARSEN.

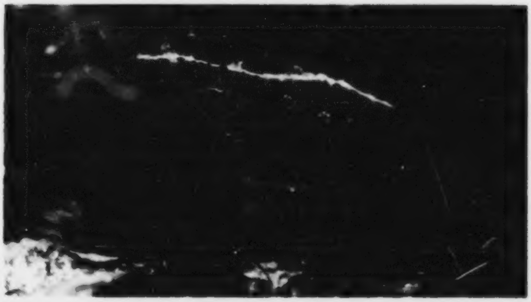
16. Boreal Chorus Frog (*Pseudacris maculata*) near Fort St John. KARL LARSEN.

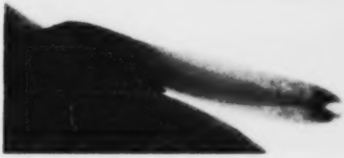
17. Pacific Treefrog (*Hyla regilla*) in Manning Park. BRENT MATSUDA.

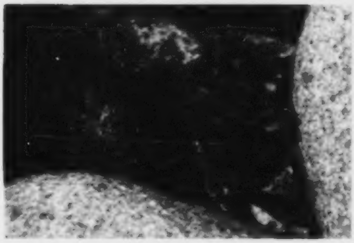
18. Pacific Treefrogs undergoing metamorphosis. BRENT MATSUDA.

19. Western Toad (*Bufo boreas*) at Ladner. DAVID GREEN.

20. Another colour variation of the Western Toad, at Big Creek, near the Chilcotin River. This toad can also be brown, black, red or any combination. BRENT MATSUDA.

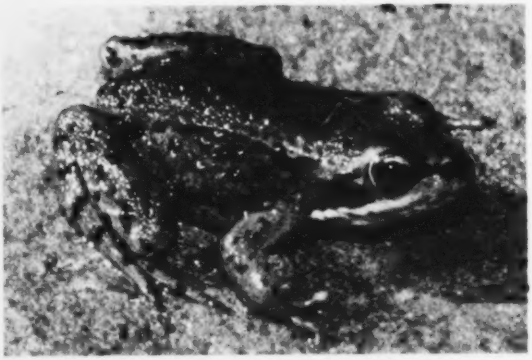


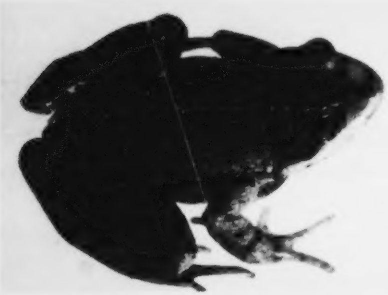




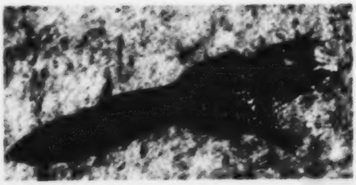
Coastal Tailed Frog (*Ascaphus truei*):
21 (above left). A tadpole clinging to a rock. DAVID GREEN.
22 (above). Frog undergoing metamorphosis. DANNY KENT.
23(left). An adult male. DAVID GREEN.

24. Juvenile Oregon Spotted Frog (*Rana pretiosa*) at the UBC Research Forest, lower Fraser River valley. BRENT MATSUDA.



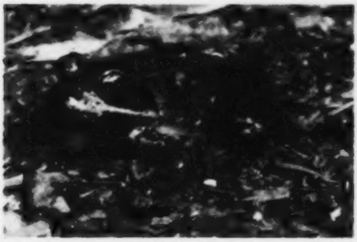


25. Cascades Frog (*Rana cascadae*). DAVID GREEN.



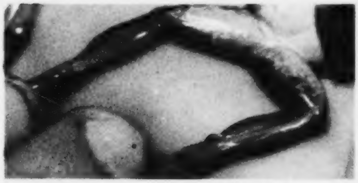
Rocky Mountain Tailed Frog (*Ascaphus montanus*):
26 (above). A tadpole near Flathead. LARRY HALVERSON.
27 (above right). Frog undergoing metamorphosis. PIERRE FRIELE.
28 (above). An adult female. PIERRE FRIELE.

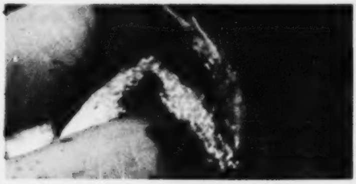
29. Wood Frog (*Rana sylvatica*) in the Peace River region. Virgil Hawkes.



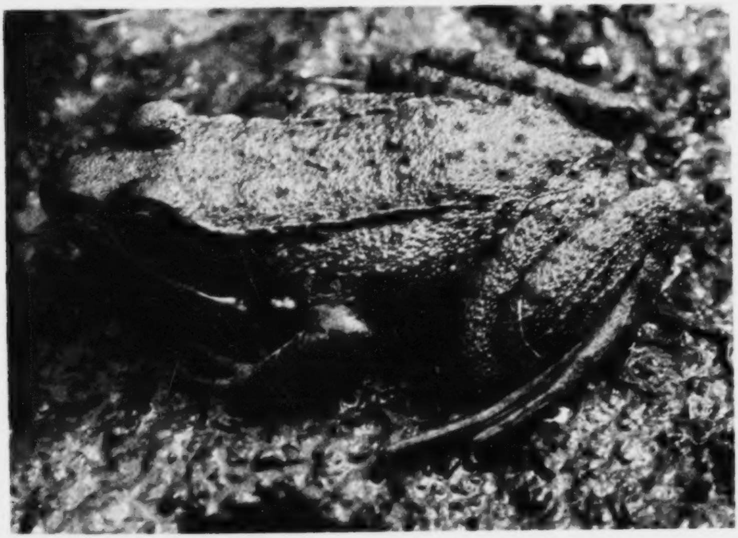
30. Adult Red-legged Frog (*Rana aurora*) in the Chilliwack River valley. **31** (below). The bones show through the frog's hind legs. This juvenile's legs are not yet red. Brent Matsuda.

32. Columbia Spotted Frog (*Rana luteiventris*) in Manning Park. **33** (below). The bones of the hind legs cannot be seen through the skin. Brent Matsuda.





34. Northern Leopard Frogs (*Rana pipiens*) near Creston. HEATHER WAYE.

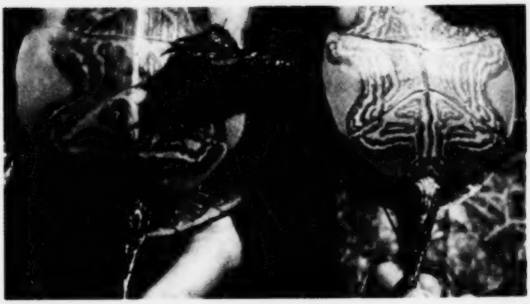


35. Green Frog (*Rana clamitans*), becoming common in Greater Vancouver. PATRICK GREGORY.

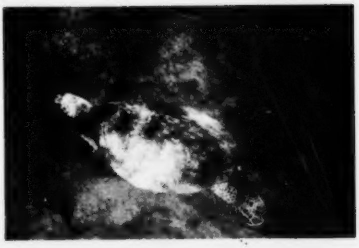
36. Bullfrog (*Rana catesbeiana*) at Vancouver. BRENT MATSUDA.

37. Red-eared Pond Slider (*Trachemys scripta elegans*) in a pond in Beacon Hill Park, Victoria, likely a released pet. GAVIN HANKE.

38. Red plastrons of male (right) and female Painted Turtles (see 39). The male's cloaca opens farther back on the tail than the female's.
KARL LARSEN.



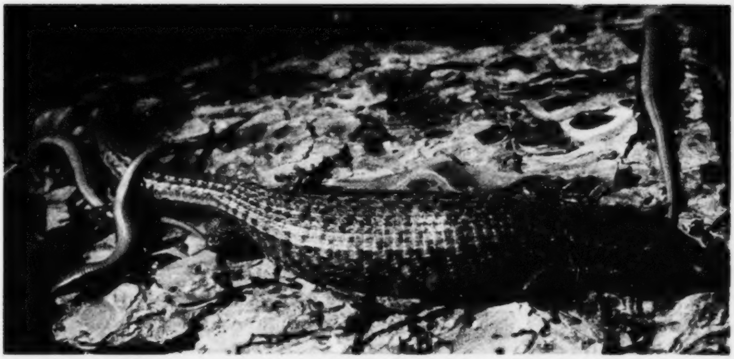
39 (above). Basking Painted Turtles (*Chrysemys picta*) at Vaseaux Lake, Okanagan Valley. JARED HOBBS.



40 (right). Green Turtle (*Chelonia mydas*), off Maui, Hawaii. This turtle sometimes ventures into B.C. waters. CHRISTINA TRUSCOTT.

41. Pigmy Short-horned Lizard (*Phrynosoma douglasii*) in Kittitas County, Washington, south of the B.C.'s Okanagan Valley. BILL LEONARD.

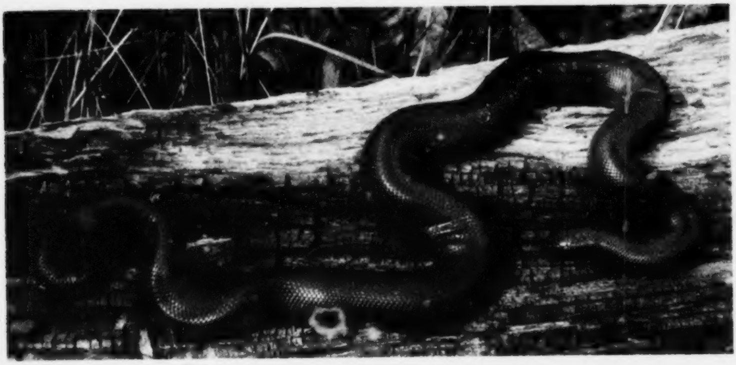
42. Common Wall Lizard (*Podarcis muralis*) invading the highlands near Victoria. GAVIN HANKE © RBCM.



43. Adult and juvenile Northern Alligator Lizards (*Elgaria coerulea*) near Sorrento, Shuswap Lake. KARL LARSEN.

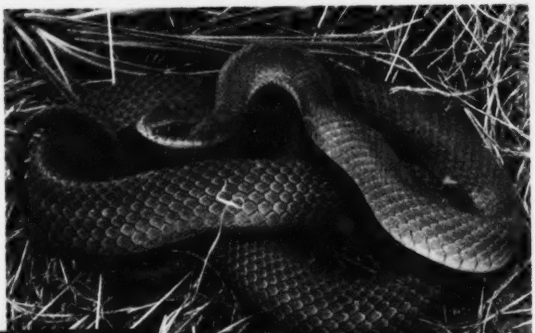
44. Northern Alligator Lizard near Cobble Hill, Vancouver Island. PATRICK GREGORY.

45. Night Snake (*Hypsiglena torquata*) in twilight. JARED HOBBS.



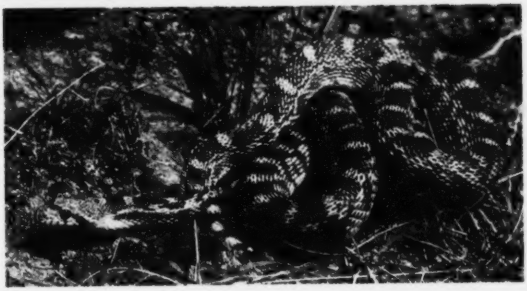
46. Rubber Boa (*Charina bottae*) near Kamloops. Karl Larsen.

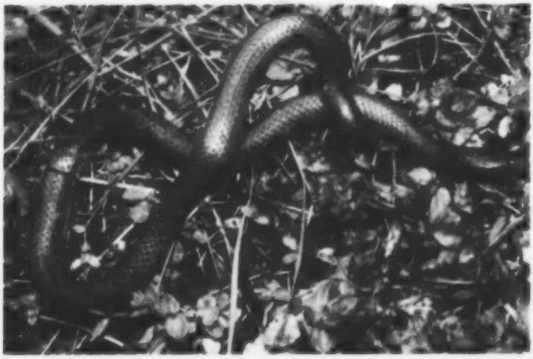
47 (right). Adult Racer (*Coluber constrictor*) near Kamloops. Karl Larsen.



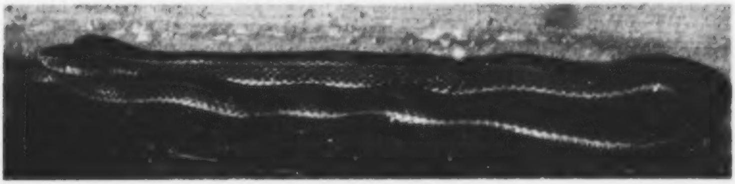
48 (below). Juvenile Racer near Vernon. Stephen Mitchell.

49. Gopher Snake (*Pituophis catenifer*) in the hills above Vaseaux Lake, Okanagan Valley. Jared Hobbs.





50. Sharp-tailed Snake (*Contia tenuis*) on Saltspring Island. PATRICK GREGORY.



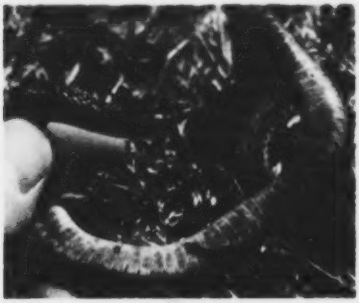
Northwestern Garter Snake (*Thamnophis ordinoides*), southern Vancouver Island:

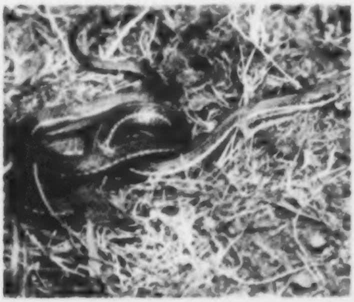
51 (above). Brown form. PATRICK GREGORY.

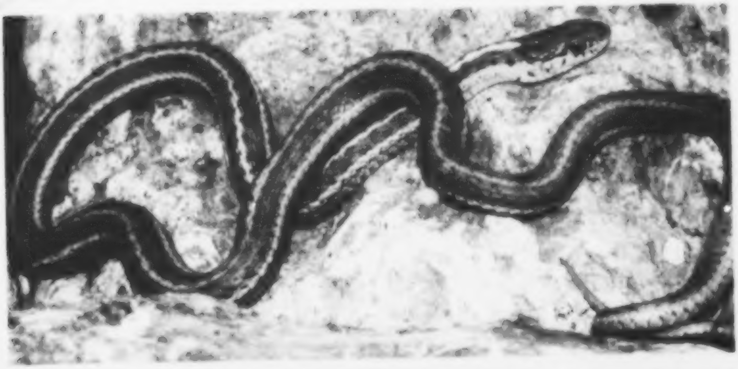
52 (left). Black melanistic form. TOM GORE.

53 (below left). With a red belly. PATRICK GREGORY.

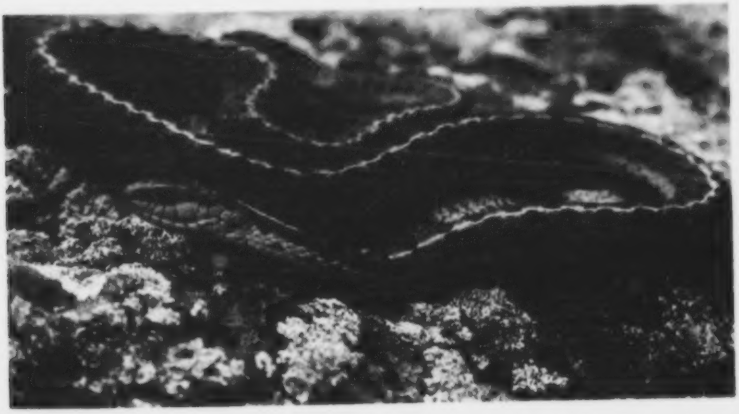
54 (below). With a distinct red dorsal stripe. PATRICK GREGORY.

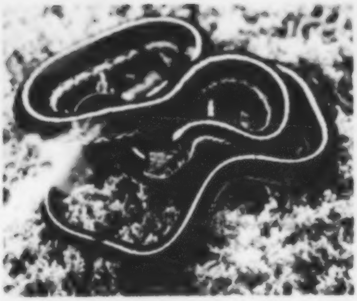






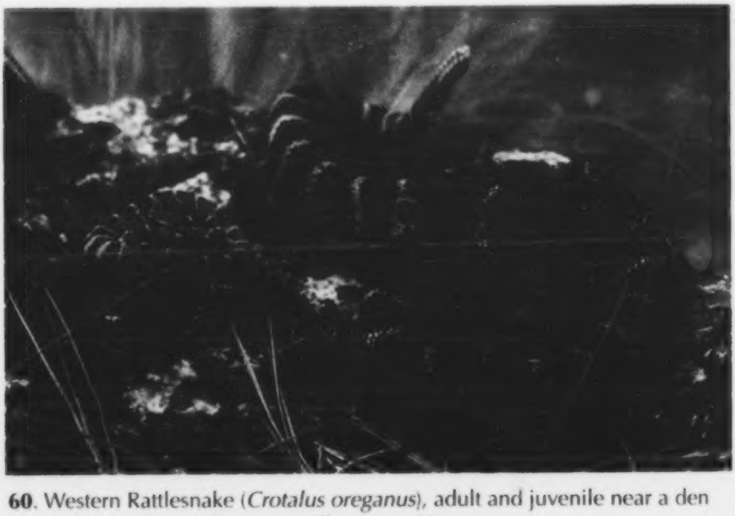
Western Garter Snake (*Thamnophis elegans*):
55 (top). Adult at Okanagan Falls, showing the prominent mid-dorsal stripe.
Patrick Gregory.
56 (above). Juveniles of two coastal varieties on Saltspring Island.
Patrick Gregory.
57 (below). An interior variety with more blotchy markings, south of Nicola Lake, near Merritt. Jared Hobbs.





58. Common Garter Snake (*Thamnophis sirtalis*) in B.C.'s interior. JAKOB DULISSE.

59. Common Garter Snake on North Pender Island. KRISTIINA OVASKA.



60. Western Rattlesnake (*Crotalus oreganus*), adult and juvenile near a den site in the southern Okanagan Valley. JARED HOBBS.

FAMILY SCINCIDAE

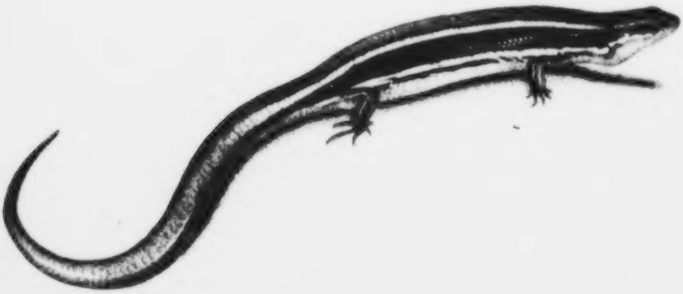
Western Skink *Eumeces skiltonianus*

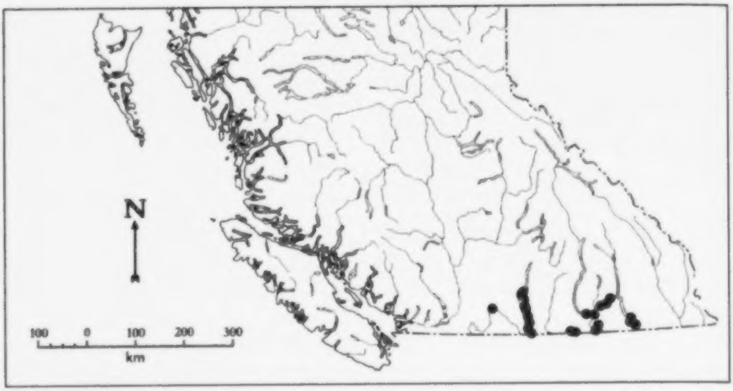
Skinks are a diverse and widespread group of lizards, occurring in many parts of the world. Three species occur in Canada; the Western Skink is British Columbia's sole representative of this family.

Description

The Western Skink's body is long and slender, up to about 80 mm long from snout to vent, with the tail up to twice as long. The head is pointed, long and narrow, and the legs are short. The body is covered with smooth, shiny scales. It has three broad, brown longitudinal stripes, separated and bordered by white stripes; this pattern is frequently less clear on the tail, which is usually greyish. The ventral surface is grey or pale blue. Breeding males develop reddish-orange patches on the sides of the head and chin, and occasionally under the tail. The pattern of young animals is similar to that of adults, but more vivid and with a bright blue tail. Some adults also have blue tails, but the colour fades to grey or brown with age. See colour photograph 1.

Distinguishing Features: The longitudinal white stripes and shiny appearance. The bright blue tail of small skinks.





Habits

The Western Skink is a diurnal species that is sometimes seen basking in sunny weather. Like many other North American skinks, however, it is a secretive species usually found under cover objects. Skinks generally live in habitats that are more damp and less open than those chosen by other kinds of lizards. The Western Skink is most commonly found in lightly wooded areas or grasslands with a lot of cover in the form of logs, rocks, leaf litter and vegetation, and is common along river banks. Sometimes this lizard burrows in soft soil. Its food usually consists of small invertebrates. The forked tongue darts in and out while foraging, but the lizard relies on sight to detect moving prey. Skinks usually escape from predators by running away with a wriggling motion, similar to the locomotion of snakes. They can also autotomize the tail. A young skink's bright blue tail directs a visually-oriented predator away from the more vulnerable head and body. When autotomized, the wiggling blue tail is an even greater distraction, often allowing the young skink to escape. A captured skink often bites.

Breeding

The Western Skink is an egg-laying species. It mates in spring and lays eggs in late June or early July. The female deposits her eggs in flask-shaped excavations dug in soft soil under rocks or other cover. She stays with the nest to tend the eggs and protect them from predators and other lizards until the eggs hatch in late summer and the young disperse from the nest. She may even leave the nest to absorb heat in the sun, and then return to transfer her body heat to the eggs. The clutch size varies from two to six. Hatchlings measure about 25 mm in snout-vent length.

Subspecies: Three are recognized: only Skilton's Skink (*Eumeces skiltonianus skiltonianus*) occurs in British Columbia.

Range

Western Skinks occur from southern British Columbia to Baja California, from the Pacific coast to Idaho, western Montana and central Utah. In British Columbia, they are found in the south of the province from Princeton in the west to Creston in the east.

Selected References: McNicholl 1975; Merilees 1981; Richmond and Reeder 2002; Rutherford and Gregory 2003a; Tanner 1943, 1957.

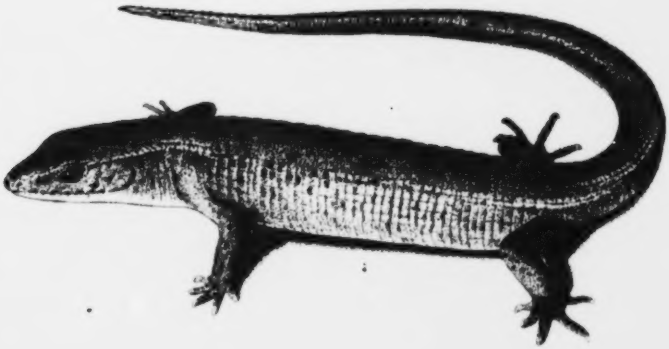
FAMILY ANGUIDAE

Northern Alligator Lizard *Elgaria coerulea*

Until fairly recently, this species was classified in the genus *Gerrhonotus*. It is the most widespread and commonly observed lizard in British Columbia, occurring almost all the way across the southern part of the province.

Description

The Northern Alligator Lizard has a slender body, 80 to 100 mm long from snout to vent, with a longer tail; females are slightly larger than males. The head is pointed, long and narrow; the legs are short. The dorsal surface and tail are covered with keeled scales. A prominent fold of skin runs lengthwise along the lower side of the body, although it may not be noticeable in pregnant females. The lateral scales are much smaller than those on the dorsal surface, and noticeable only when the sides are expanded. The back is dull brown or tan with scattered black blotches, sometimes forming irregular or incomplete transverse bands. These blotches are usually largest on the sides and are sometimes absent from the mid-dorsal area. There are scattered spots on the tail. The ventral surface is greyish. The young are more metallic in appearance, with blackish sides and a copper-brown back. See colour photographs 43 and 44.



Distinguishing Features: The dull brown appearance. The brighter copper colour of small lizards.

Habits

The Northern Alligator Lizard is secretive and commonly found under rocks or logs, although it is sometimes seen sunning itself in exposed places. Typical habitats are open rocky areas, especially near woods or in forest clearings. Although often locally abundant, this species is patchily distributed throughout its range. Its diet consists mainly of small invertebrates such as insects and spiders. The Northern Alligator Lizard tends to be most gregarious in spring and fall around hibernating sites, and less so in summer when dispersed away from such sites. Its main protection against predators is to flee, although it is not particularly fast unless its body temperature is quite high. If caught, it may bite and void the contents of its cloaca, much like a snake. This lizard can also autotomize its tail to distract a predator.

The Northern Alligator Lizard is of minor economic importance as the main host of the young stages of the tick, *Ixodes pacificus*. Although this tick is not known to transmit any diseases, at high densities it may affect the health of livestock and wild mammals by causing anemia and general irritation.

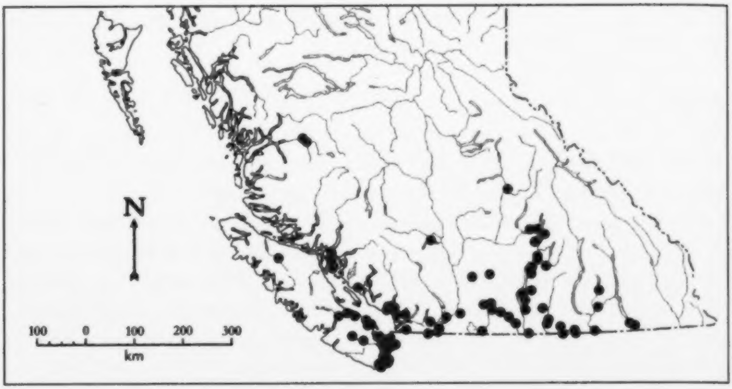
Breeding

The Northern Alligator Lizard bears live young. Courtship and mating occur in spring and the young are born in late summer or early fall. The average litter size in British Columbia populations is about five, and newborns measure 25 to 30 mm in snout-vent length. Males chase females in courtship, and during copulation, which can last for several hours, the male holds the female's head in his jaws.

Subspecies: Four are recognized: only the Northwestern Alligator Lizard (*Elgaria coerulea principis*) occurs in British Columbia.

Range

The Northern Alligator Lizard is found in southern British Columbia and south along the Pacific coast to middle California; it also occurs in northern Idaho and eastern Montana. In British Columbia, it inhabits a narrow belt across the southern part of the province, north to Clearwater inland in the Thompson River valley



and to Stuie near Bella Coola on the coast. The range also includes eastern Vancouver Island and the adjacent mainland coast. It is absent from the extreme southeastern corner of the province.

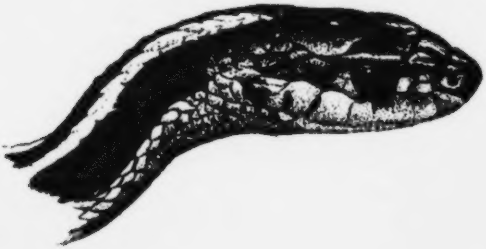
Selected References: McNicholl 1980; Rutherford 2004; Rutherford and Gregory 2003a, b; Stewart 1977; Vitt 1973, 1974.

Snakes

The earliest known fossil snake is about 100 million years old, which makes snakes a more recent group than mammals. Taxonomists surmise that snakes evolved from a lizard-like ancestor and include them in the same order as lizards, the Squamata. The most primitive modern snakes are burrowing animals, so snakes may have evolved from burrowing lizards. Another hypothesis is that snakes are most closely related to the extinct, aquatic mosasaurs of the Mesozoic Era and their relatives, the monitor lizards. The origin of snakes remains a matter of dispute.

Snakes have a long, slender body. Their internal organs are also long and narrow, and paired organs (such as kidneys) and reproductive organs are arranged in a linear fashion. Most snakes have only the right lung; more primitive snakes, such as boas, have two lungs, but the left one is usually smaller. Snakes are distinguished from limbless lizards by their more flexible body and lack of eyelids (although some lizards also lack eyelids). Snake species vary in maximum length from less than 30 cm (e.g. the Flat-headed Snake, *Tantilla gracilis*, of south-central USA) to about 10 metres (the Reticulated Python, *Python reticulatus*, and the Anaconda, *Eunectes murinus*). The most primitive living snakes still have small vestiges of pelvic girdles and limbs; no snakes have any trace of the forelimbs or pectoral girdle. A local example of a primitive snake is the Rubber Boa. Most snakes are terrestrial, but many species are aquatic or arboreal.

All snakes are carnivores and swallow their prey whole, but they have a variety of feeding mechanisms. The simplest is probably the most common: the snake grabs prey animal with its mouth, usually by the head, and swallows it alive. Our garter snakes eat mainly this way. Heavier bodied snakes may also swallow their



food alive but use their body weight to hold down and subdue the prey. In some cases, this pressure can kill the prey, which is better for the snake. Eating a dead animal, rather than a struggling one, reduces the snake's risk of injury and makes swallowing easier. Most snakes kill their prey by constriction or envenomation. A constrictor coils its body around the prey in loops, tightening the coil each time the prey exhales, eventually killing it by suffocation or heart failure. It does not crush its prey. Constrictors, including the Rubber Boa and Gopher Snake, are well-muscled and feed mainly on birds and mammals. Venomous snakes inject poison into prey via fangs, which are grooved (as in some venomous colubrid snakes) or hollow like hypodermic needles (as in elapids and ids).

Apart from the fangs, the teeth of snakes are usually short, sharp and curved backwards to prevent prey from slipping out of the mouth. Snakes can swallow relatively large food items. Their skull is kinetic and their skin elastic. The two halves of the lower jaw are connected at the front by a ligament that can be stretched and the two sides of both upper and lower jaws can move independently. A snake swallows by "walking" the four quadrants of its jaws over the prey. The windpipe opens into the floor of the mouth, permitting the snake to breathe during the sometimes lengthy process of swallowing food. Snakes in the African genus *Dasypeltis* are prodigious swallowers; they have few small teeth, but the skull is highly specialized for engulfing large, round eggs.

Selected References: Bauchot 1994, Ernst and Zug 1996, Greene 1997, Siegel and Collins 1993, Siegel et al. 1987, Stafford 2000.

Keys to the Snakes of British Columbia

Snakes present problems for identification, because some species of venomous snakes look similar to non-venomous snakes. In British Columbia, the mildly venomous Night Snake is too small and inoffensive to be dangerous to humans, but the highly venomous Western Rattlesnake can be very dangerous. So it is useful to have a key that does not require handling of the snake. Similar-looking snakes may require a more detailed examination. Consequently, we provide two keys: one for safe field identification and the other for dead specimens in the laboratory. Exercise caution when handling dead specimens, because snake venom does not lose its potency immediately upon the death of the animal; a scratch from a fang could still be dangerous.

Field Key to the Snakes of British Columbia

1a. Button or rattle on end of tail; series of dark blotches along the back, but sometimes dark overall; head large and triangular . . . . .Western Rattlesnake (*Crotalus oreganus*)
1b. No button or rattle on end of tail 2

2a. Series of blotches along the back 3
2b. No dorsal blotches 5

3a. Dorsal blotches often paired, only somewhat larger than those on side; three distinct dark brown blotches on back of neck; pupil of eye vertically elliptical . . . . .Night Snake (*Hypsiglena torquata*)
3b. Dorsal blotches single and substantially larger than those on side 4

4a. Blotches dark brown against yellowish background . . . . .Gopher Snake (*Pituophis catenifer*)
4b. Blotches brownish against blue-grey background; small snake . . . . .Racer (*Coluber constrictor*)

5a. Back uniform brown or grey-blue; skin usually shiny (smooth scales) 6
5b. Back not uniform brown or grey-blue 7

6a. Back uniform brown; body short and stout with blunt head and tail; eye small relative to head
. . . . .Rubber Boa (*Charina bottae*)

6b. Back uniform grey-blue; body long and slender; well-defined head and long, whip-like tail. . . . . . .Racer (*Coluber constrictor*)

7a. Longitudinal mid-dorsal stripe along back 8

7b. No dorsal stripe 9

8a. Mid-dorsal stripe straight-sided and bright yellow; black background, often with red blotches on side of body
. . . . .Common Garter Snake (*Thamnophis sirtalis*)

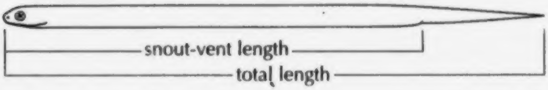
8b. Back brown with yellow stripe or black with red stripe; stripe often faint, broken or zigzagged 10

9a. Back brown with slight checkering, or uniform black, not shiny; red blotches possibly on ventral surface
. . . . .Northwestern Garter Snake (*Thamnophis ordinoides*)

9b. Back greyish, yellow-brown or reddish-brown, usually with yellowish or reddish stripe along each side; tail sharp and pointed; small snake (less than 500 mm snout-vent length)
. . . . .Sharp-tailed Snake (*Contia tenuis*)

10a. Back brown with yellowish mid-dorsal stripe (often faint) or black with red mid-dorsal stripe (often incomplete or broken); red blotches possibly on ventral surface
. . . . .Northwestern Garter Snake (*Thamnophis ordinoides*)

10b. Mid-dorsal stripe usually a zigzag; two rows of alternating dark blotches often on sides of body; sometimes bluish all over . . . . .Western Garter Snake (*Thamnophis elegans*)



Laboratory Key to the Snakes of British Columbia

1a. All body scales keeled 2
1b. Some or all body scales smooth 5

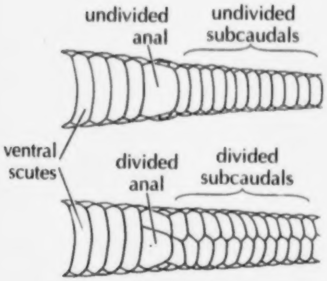
2a. Pit on side of head between nostril and eye; button or rattle on end of tail .... Western Rattlesnake (*Crotalus oreganus*)
2b. No pit or rattle 3

3a. 17 rows of body scales at mid body .... Northwestern Garter Snake (*Thamnophis ordinoides*)
3b. More than 17 rows of body scales at mid body 4

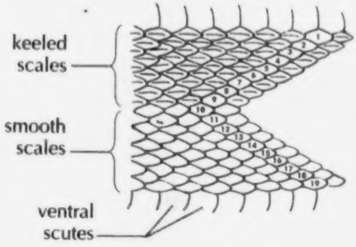
4a. 19 rows of body scales at mid body .... Common Garter Snake (*Thamnophis sirtalis*)
4b. 21 rows of body scales at mid body .... Western Garter Snake (*Thamnophis elegans*)

5a. Scutes on back slightly keeled, all other body scales smooth; series of dark brown blotches along back; dark line across head in front of eyes and a dark band from eye to angle of jaw .... Gopher Snake (*Pituophis catenifer*)
5b. All body scales smooth 6

6a. Head and tip of tail blunt; 44 to 45 rows of body scales at mid body; eye small relative to head . . Rubber Boa (*Charina bottae*)
6b. Fewer than 44 rows of body scales at mid body 7


undivided anal
undivided subcaudals
ventral scutes
divided anal
divided subcaudals

lateral view


keeled scales
smooth scales
ventral scutes

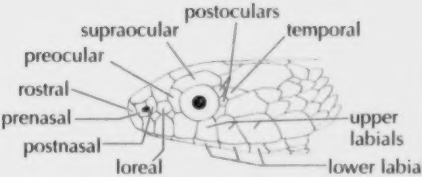
dorsal view

7a. 21 rows of body scales at mid body; yellow-grey background with numerous brown blotches, the mid-dorsal row often occurring in pairs; three dark-brown blotches on back of neck; pupil of eye vertically elliptical
. . . . .Night Snake (*Hypsiglena torquata*)

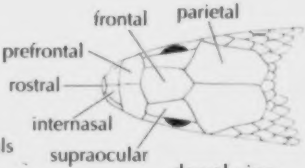
7b. Fewer than 21 rows of body scales at mid body 8

8a. 15 rows of body scales at mid body; tail with sharp, pointed scute at tip; usually a yellowish or reddish stripe along each side; small (less than 500 mm snout-vent length)
. . . . .Sharp-tailed Snake (*Contia tenuis*)

8b. 15-17 rows of body scales at mid body; head large with large eyes; tail long and whip-like; back grey-blue, although some small specimens have series of large blotches
. . . . .Racer (*Coluber constrictor*)


postoculars
supraocular
temporal
preocular
rostral
prenasal
postnasal
loreal
upper labials
lower labials

lateral view


frontal
parietal
prefrontal
rostral
internasal
supraocular

dorsal view

FAMILY BOIDAE

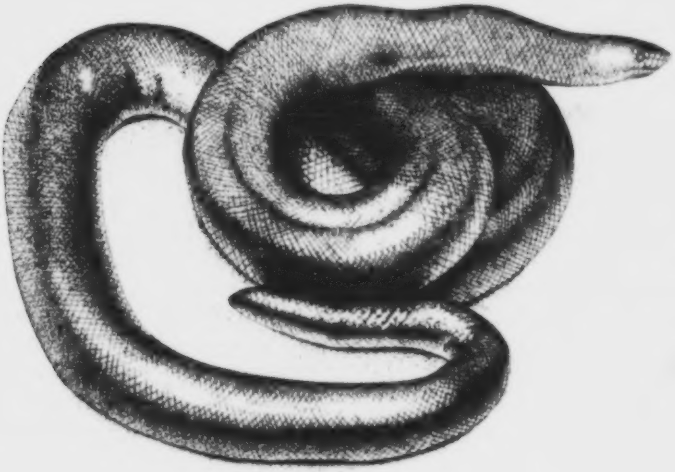
Rubber Boa *Charina bottae*

Other Names: Northwestern Rubber Boa.

The Rubber Boa is the northernmost member of a large family of snakes best known for its large, tropical members such as the Boa Constrictor (*Boa constrictor*). Unknown to most people, the Rubber Boa is one of our most widely distributed snakes and, although secretive, can be fairly common at some sites.

Description

The Rubber Boa's body is short and stout with a short, blunt tail. Adults can grow to 830 mm long, but are usually smaller. The back is uniformly brown, sometimes tinged with grey, yellow or green, and the underside is yellow. The head is rounded, blunt and not distinct from the neck. The eye is small, with a vertical pupil. The plates on top of the head are large and irregular and the body scales are small and smooth. This snake has a single anal plate, with a small spur in a pit on each side, though the spurs are often not visible in females. It has a single row of subcaudal scutes. See colour photograph 46.



Distinguishing Features: The uniformly brown back, and blunt, rounded head and tail. Slow movement.

Habits

The common name of the Rubber Boa comes from its plasticine-like appearance. This is a sluggish and inoffensive snake. Sometimes, when alarmed, it will roll itself into a ball with its head in the centre and the tail sticking out. Because the tail mimics the head in appearance, this behaviour can divert the attention of a predator from the head to the less vulnerable tail, which is strengthened by specialized terminal vertebrae. Because of the similarity of head and tail, the Rubber Boa is sometimes called a two-headed snake.

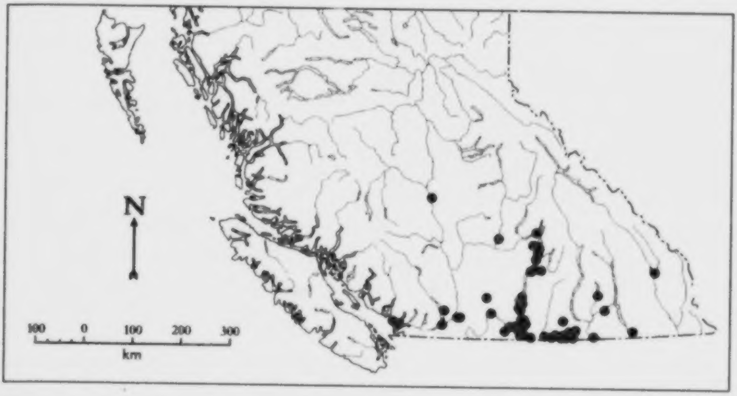
The Rubber Boa appears to be primarily a snake of humid, mountainous regions, although it also occurs in drier, lowland localities, and is often associated with clearings in forests. It is secretive and rarely seen, most often found under cover objects such as rocks and logs, and it may also burrow. Because this species is nocturnal, it is sometimes encountered late at night as it crosses a road. It is tolerant of cold – a free-ranging Rubber Boa can have a body temperature as low as 11°C.

The Rubber Boa kills its food by constriction, causing suffocation or heart failure, as do the larger, tropical members of its family. The major component of its diet appears to be small mammals, especially nestlings, although it also eats lizards.

Breeding

The Rubber Boa bears live young. Mating takes place in spring and the young are usually born in early autumn. Litter size ranges from two to eight, and newborn young range from 180 to 280 mm long. Almost nothing else is known about the breeding habits of the Rubber Boa. The male uses his spurs, which are vestigial hind limbs, to stroke the female during courtship and mating, as has been observed in other boas.

Subspecies: None are recognized in the current British Columbia taxonomic catalogue (Gregory and Gregory 1999). But some scientists recognize two or three subspecies, of which the Pacific Rubber Boa (*Charina bottae bottae*) occurs in British Columbia. Recent work suggests that the two commonly recognized subspecies are actually different species, with *Charina bottae* occurring in British Columbia.



Range

Rubber Boas are found from British Columbia south to the San Bernardino Mountains in California and east to western Montana, western Wyoming and Utah. In British Columbia, the Rubber Boa occurs across the southern part of the province as far north as Dog Creek and east to Radium Hot Springs and Canal Flats in the Kootenay region. An early record for Vancouver Island is of doubtful validity.

Selected References: Dorcas and Peterson 1997, Dorcas et al. 1997, Hoyer and Stewart 2000, Rodríguez-Robles et al. 2001.

FAMILY COLUBRIDAE

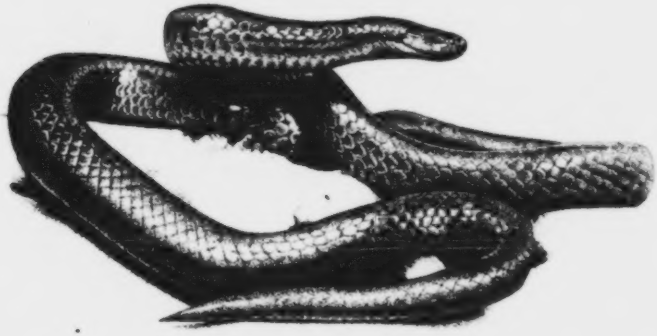
Sharp-tailed Snake *Contia tenuis*

Other Names: Sharptail Snake.

This is the smallest species of snake in British Columbia. It also has one of the smallest and most fragmented distributions of all our snakes. These factors, coupled with its secretive habits, mean that it is only rarely seen and relatively little is known about its habits.

Description

The body of the Sharp-tailed Snake is short (205 to 455 mm long) and stout; the tail is short and tapers to a sharply pointed scute. The head is wider than the neck and has a broad, rounded snout. The eye is small with a round pupil. The body scales are smooth and the anal plate double. The back is greyish, yellowish-brown or reddish-brown, tending to be reddish on the tail. The body sometimes has fine black dots and usually a wide yellowish or reddish stripe along each side. The scales below the stripe are dotted with black, forming a continuous band in young individuals. The ventral surface is whitish, greyish or yellowish with a conspicuous transverse dark bar on each scale. The top of the head is dark brown and the chin light. See colour photograph 50.



Distinguishing Features: Small with a sharply pointed tail and ladder-like ventral pattern. Seen briefly and without examination, this snake can be confused with a small Northwestern Garter Snake.

The sharp tip of a Sharp-tailed Snake's tail. PATRICK GREGORY.

Habits

Because the Sharp-tailed Snake is secretive and its distribution in British Columbia is scattered, the status of this species is difficult to assess. Only recently has any substantive research been done on its ecology in British Columbia, and much remains unknown about the natural history of this snake.

The Sharp-tailed Snake is found in woodlands and forests, often near forest edges or in clearings. It seems to prefer cool, moist environments and is possibly nocturnal. It is usually found under cover or in rotting logs. Its occasional activity on the surface mainly occurs in spring and autumn, and reported movements are modest. Sharp-tailed Snakes tend to gather in groups. They mainly eat slugs.

The function of the pointed tail is not known. It may be used to help push the body forward when the snake is climbing an incline. When picked up, some Sharp-tailed Snakes lightly push the pointed tail-tip into the person's hand, and small ones often coil into a ball, with head hidden.

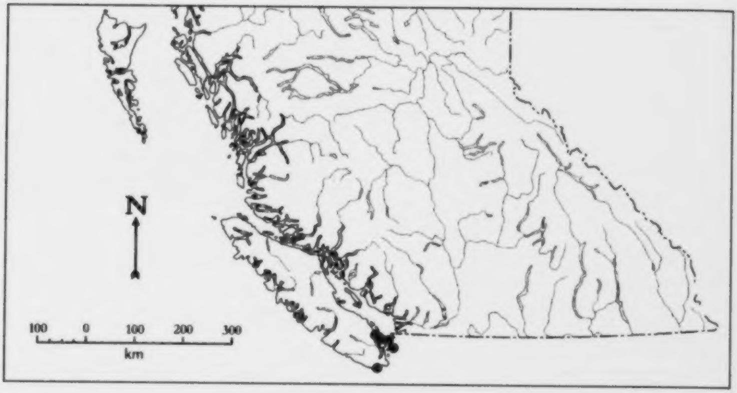
Breeding

Little is known about the breeding habits of the Sharp-tailed Snake except that it is an egg-layer, producing two to five eggs per clutch, and that hatchings are about 75 to 92 mm in snout-vent length.

Subspecies: None.

Range

There are scattered occurrences of Sharp-tailed Snakes in British Columbia and Washington. The main, continuous part of the range of this species extends from western Oregon to central California.



In British Columbia, Sharp-tailed Snakes have been found on seven Gulf Islands and a few localities on southern Vancouver Island. Although this distribution might be due simply to the secretive nature of the snake and the resulting scarcity of recorded specimens, it is more likely that the British Columbia populations are relicts of a wider range in the past. Two specimens of questionable origin were reported caught near Chase in 1964.

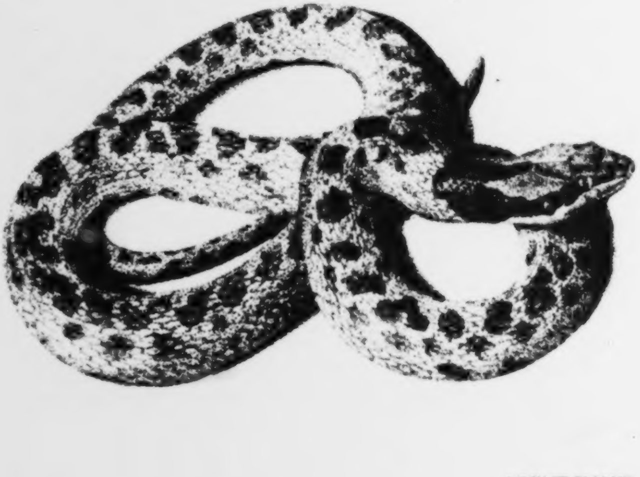
Selected References: Carl 1971; Engelstoft et al. 1999; Leonard and Stebbins 1999; Ovaska and Engelstoft 1999; Spalding 1993, 1995.

Night Snake *Hypsiglena torquata*

Although the Night Snake has a very wide range in North America and is often abundant, it barely ranges into Canada and may be our rarest snake. Only 30 specimens have been positively identified, with several unconfirmed sightings, since the species was first reported in British Columbia in 1980. But its secretive nature and its superficial resemblance to some other species may mask its true abundance.

Description

The Night Snake is small and slender, although those in northern regions, including British Columbia, reach larger sizes than elsewhere. Night Snakes in this province can measure up to 525 mm in snout-vent length and 605 mm in total length. The head is nearly flat and triangular, with the eyes slightly upturned. The pupil of the eye is vertical. The body scales are smooth and arranged in 21 rows at mid body. The anal plate is divided and the subcaudal scutes are in two rows. The dorsal surface is grey or yellowish-brown with numerous darker grey-brown spots. It has a mid-dorsal row of blotches that are usually paired with an alternating row of smaller blotches on each side and a second row of still smaller spots low on each side. The back of the neck has three distinct dark brown blotches, the middle one wider at the rear so that it covers most of the nape; the configuration of these blotches



varies considerably and they may or may not be connected. The upper labial scutes are whitish and there is a dark brown bar behind the eye, running backward and downward, with a narrower bar running forward in front of the eye. The ventral surface is white or yellowish, with no pattern. See colour photograph 45.

Distinguishing Features: The paired dorsal blotches and dark blotches on the back of the neck. Vertically elliptical pupils. The Night Snake's blotched pattern makes it difficult for the novice to distinguish from other blotched snakes in British Columbia. At first glance it can be confused with a small Gopher Snake, Western Rattlesnake or Racer, which also are blotched, so care should be taken in identifying doubtful specimens.

Habits

The Night Snake is a secretive, nocturnal snake, whose natural history is poorly known. In some parts of its range it is abundant but rarely seen. During the day, it is usually found under rocks or other cover, but can be seen crossing roads at night when it forages for prey. This species occurs in a variety of habitats but is generally associated with arid regions, especially sandy and rocky habitats. It is probably rare in British Columbia.

The Night Snake is our only rear-fanged venomous snake. The fangs are enlarged teeth at the back of the upper jaw and only slightly grooved, if at all. The venom is toxic to the snake's usual prey, mainly small lizards and frogs, and administered along the fangs, accompanied by a motion resembling chewing. This venom paralyses a small lizard in seconds, although it takes much more time to kill it. One Night Snake captured in British Columbia regurgitated a young Western Rattlesnake; in captivity, it and another Night Snake readily ate other snakes, lizards and small frogs, but did not exhibit any obvious use of their fangs in subduing them. Night Snake venom is not known to be dangerous to humans, unlike that of some large rear-fanged snakes in other parts of the world. In any case, the Night Snake is small and rarely, if ever, attempts to bite when handled.

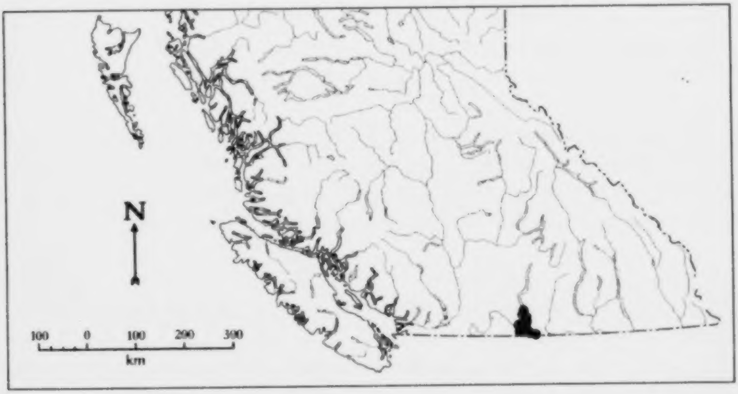
Breeding

The Night Snake is an egg-laying species, but nothing is known of its reproductive habits in British Columbia. Information on reproduction is scant throughout its range. In Idaho, where the nearest study was done, eggs are laid in June. Eggs at that site varied in width from 2.9 to 6.2 mm and in length from 8.4 to 20 mm. Newly hatched snakes in Arizona ranged from 134 to 160 mm in snout-vent length, but size at hatching might be larger in British Columbia, given the larger size of adults here.

Subspecies: Seven are recognized, with only one in British Columbia: the Desert Night Snake (*Hypsiglena torquata deserticola*).

Range

The Night Snake is found from British Columbia, through central Washington, eastern Oregon, southern Idaho, Nevada, Utah, and across the southern United States from California to central Texas; south throughout Mexico and Central America to Costa Rica. In British Columbia, the Night Snake is known only from the southern Okanagan and Similkameen River valleys in the southern dry interior.



Selected References: Diller and Wallace 1986, Lacey et al. 1996, Rodrígues-Robles et al. 1999.

Racer *Coluber constrictor*

Although the Racer is restricted to hotter parts of southern British Columbia, its daytime activity, large size and speed make it a fairly conspicuous snake in appropriate habitat.

Description

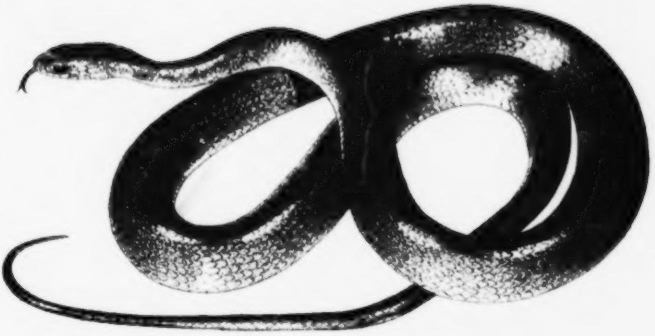
The Racer's body is long and slender with a long, whip-like tail. Most adults in British Columbia measure less than 1000 mm from snout to vent, but some reach 1160 mm. The head is large and distinct from the neck. The eye is large with a round pupil. The body scales are smooth and the anal plate divided. Adult dorsal colour is uniform greyish or olive, becoming greenish or bluish on the lower sides; the skin between the scales is often black. The belly is yellow. The young are similar but with a series of 70 to 85 brown saddle-shaped cross-bands along the back and smaller blotches on the sides. These markings become progressively fainter as the snake grows and they eventually disappear. See colour photographs 47 and 48.

Distinguishing Features: The plain blue-grey appearance and active behaviour, especially in warm weather. A small Racer's blotchy pattern may confuse it with another species, but it can by distinguished by slender body, large head and large eyes.

Habits

The Racer's common name reflects its speed and agility. Although often abundant where found, it is usually difficult to catch. Captured individuals can behave pugnaciously, striking repeatedly and sometimes vibrating the tail. The Racer is a large, active predator that commonly moves with its head raised above the ground. This snake is active during daylight and is probably the most heat-tolerant species of snake in British Columbia. It climbs well and is sometimes found in bushes. Its usual habitat is open, sparsely treed country, but Racers can pass the winter in more forested areas where they share hibernating dens with Western Rattlesnakes, Gopher Snakes and garter snakes.

The Racer eats mostly small mammals and insects, but also frogs, lizards, other snakes and birds. Despite its scientific name, the Racer does not constrict its prey but simply pins large prey down with its body while swallowing it.



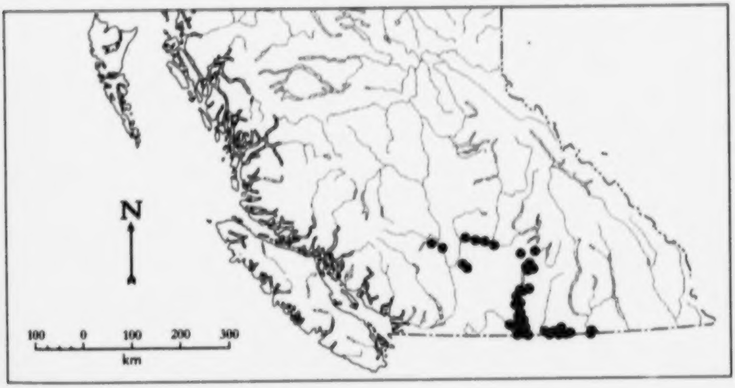
Breeding

This species mates in spring and lays eggs in late June or early July, sometimes in communal nests with other snakes, often in abandoned rodent burrows. In British Columbia, the clutch size ranges from three to nine. The eggs measure 30 to 42 mm long and 19 to 21 mm wide. They usually hatch in late summer. In British Columbia, newly hatched Racers average 237 mm in snout-vent length.

Subspecies: At least eight are recognized, but only one occurs in British Columbia: the Western Yellow-bellied Racer (*Coluber constrictor mormon*), also called the Western Yellowbelly Racer.

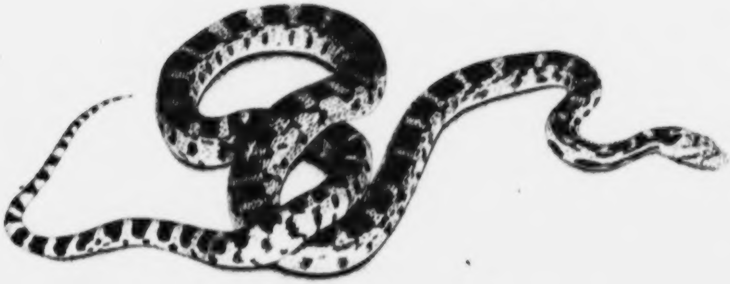
Range

The Racer occurs over most of the United States and several adjacent parts of southern Canada. It is absent from the southwestern



United States and the northern Mississippi River area. In British Columbia, it is restricted to the dry southern interior, especially in the area bounded by the Okanagan Valley and the Similkameen, Fraser and Thompson River valleys.

Selected References: Brown and Parker 1976, Fitch 1999, Greene 1984.



Gopher Snake

Gopher Snake *Pituophis catenifer*

Other Names: Bullsnake.

The Gopher Snake is our largest non-venomous snake. Although it can be secretive at times, it often can be seen in the open in daytime, making it one of our better known species. Unfortunately, Gopher Snakes are sometimes mistaken for rattlesnakes and killed unnecessarily.

Description

The Gopher Snake's body is long and robust, and the tail is moderately long. Adults can measure from 915 to 1800 mm long. The head is slightly larger than the neck and the snout is narrow and projects beyond the lower jaw. The eye is large with a round pupil. The scales on the back are lightly keeled and those on the sides smooth. The anal plate is single. The dorsal background colour is usually pale yellow or greyish-yellow and the keels on the scales are dark brown. Superimposed on this is a series of 45 to 55 dark-brown blotches along the back, beginning behind the head. These become a series of 12 to 16 dark-brown cross-bands on the upper surface of the tail. There are also several series of smaller blotches or spots along the sides of the body. The Gopher Snake also has a dark line across the head in front of the eyes, a dark band from the eye to the angle of the jaw, and a dark vertical spot below the eye. The belly is yellow or yellowish-white with brown or black spots. See colour photograph 49.

Distinguishing Features: Because the Gopher Snake has a blotched pattern like several other snakes, it is not always immediately recognizable without close inspection. But an adult is much larger than any other blotched, harmless snake and it is more slender and generally brighter in colour than the Western Rattlesnake in British Columbia. It also lacks a rattle on the tip of its tail. If in doubt, leave the snake alone.

Habits

In British Columbia, the Gopher Snake is found mainly in dry grasslands, sometimes associated with wetlands, although it may enter more forested areas to hibernate. It is a good climber. In winter, Gopher Snakes often share communal dens with rattlesnakes and other snake species. Contrary to popular belief, Gopher Snakes do not lead rattlesnakes to dens, do not commonly eat rattlesnakes, and do not interbreed with them.

When disturbed, this large snake often hisses loudly, strikes and bites. Loud hissing is made possible by a modification of the epiglottis into an erect and flexible structure that vibrates in the stream of air forced from the windpipe. The Gopher Snake can make its hiss pulse so that it sounds like a rattlesnake's rattle. It can also vibrate its tail rapidly, and if lying in loose debris, this also sounds like a rattling rattlesnake. These behaviours, together with the snake's superficial resemblance to a rattlesnake, sometimes results in the Gopher Snake being slain as a dangerous animal.

Gopher Snakes are mostly active at twilight, but can be seen at all times of day or night; they spend much time hidden in rodent burrows or other retreat sites. They are economically important animals, because they prey on small mammals, some of which are major crop pests. Gopher Snakes also eat nestling birds. They usually kill their prey by constriction.

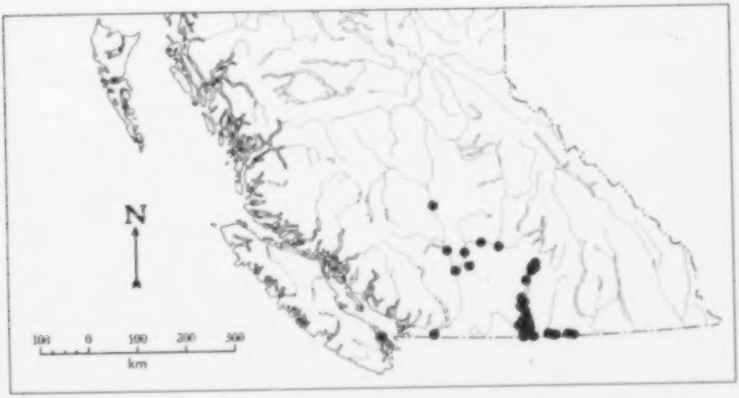
Breeding

The Gopher Snake lays eggs, sometimes communally with Racers and other Gopher Snakes. Mating occurs in spring and the eggs are laid in late June or early July, hatching in late summer. Clutch size ranges from two to eight in British Columbia. Eggs measure up to 30 by 70 mm and hatchlings average 370 mm in snout-vent length. Mating behaviour has been described in some detail for this species and is readily observed in captivity. Typically, as in most snakes, the male aligns his body with the female's and climbs on top of her. The male usually grasps the female with his jaws on her back and neck, apparently stimulating her. Sometimes, two male Gopher Snakes engage in this activity. In such cases, the behaviour is referred to as a "combat dance", though it is not necessarily related to disputes over mates; combat dances have not been recorded in British Columbia.

Subspecies: Six are recognized, of which two have been reported in British Columbia: the Pacific Gopher Snake (*Pituophis catenifer catenifer*) has anterior dorsal blotches that are separated from one another and from the secondary blotches on the side of the neck; the Great Basin Gopher Snake (*P. c. deserticola*) has blotches that are usually connected with one another and with the secondary blotches to form a longitudinal stripe on the side of the neck. *Pituophis catenifer* was previously treated as a set of subspecies of a single transcontinental species, *P. melanoleucus*, which continues to be the subject of much taxonomic dispute.

Range

The Gopher Snake is widely distributed over most of the western United States and parts of adjacent Canada. Validity of the subspecies *Pituophis catenifer catenifer* in British Columbia is debatable, a single specimen having been taken from Galiano Island in 1957. Another questionable specimen was reported in the 1800s from Sumas, Washington, on the Canadian border. But even if it once naturally occurred here, the subspecies is now extirpated in this province. In British Columbia, the subspecies *P. c. deserticola* is confined to the southern dry interior, mainly the Thompson-Okanagan region.



Selected References: Diller and Wallace 1996, Ministry of Environment 1998b, Rodríguez-Robles and De Jesus-Escobar 2000, Shewchuk 1996.

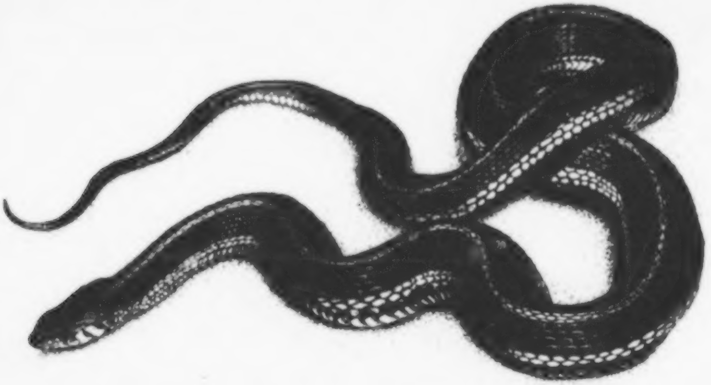
Common Garter Snake *Thamnophis sirtalis*

The Common Garter Snake is the most widespread snake species in North America and is found in much of southern Canada, from the Atlantic to the Pacific and as far north as the Northwest Territories. It occurs further north than any other species and is the only snake in many northern areas. Because it is also abundant and active in the open during the day, the Common Garter Snake is the most familiar snake in British Columbia.

Description

Common Garter Snakes in British Columbia grow to maximum sizes of 650 to 800 mm in snout-vent length and 830 to 1025 mm in total length, but size can vary greatly from one population to another. Females are larger than males. The head is large and distinct from the neck. The eye is large with a round pupil. There is one preocular scute and usually seven upper labial and ten lower labial scutes; the posterior upper labials often have a red or dark blotch. In mainland specimens, the posterior part of the head is often marked by red; this colouration is less common on Vancouver Island specimens. The body scales are strongly keeled, with 19 rows at mid body, and a single anal plate. The background colour is usually black or dark brown and the skin between the scales may be red, producing a series of red vertical bars or blotches on the sides of the body. But the red is often absent, especially in Vancouver Island specimens. Three yellow or greenish-yellow stripes run the length of the body, one mid-dorsal and one on each lower side. The mid-dorsal stripe includes the middle row of scales and part of the row of body scales on each side. The top of the head is usually uniform black, brown or olive-green and the upper lip yellow The ventral surface varies from yellow to black and the chin and throat are usually pale yellow. See colour photographs 58 and 59.

Distinguishing Features: Depending on location, the Common Garter Snake can be confused with other garter snakes and may have to be examined carefully for correct identification. In British Columbia, it can be distinguished by its dark background colour, bright yellow dorsal and lateral stripes, and red colouration often arranged in lateral bars.



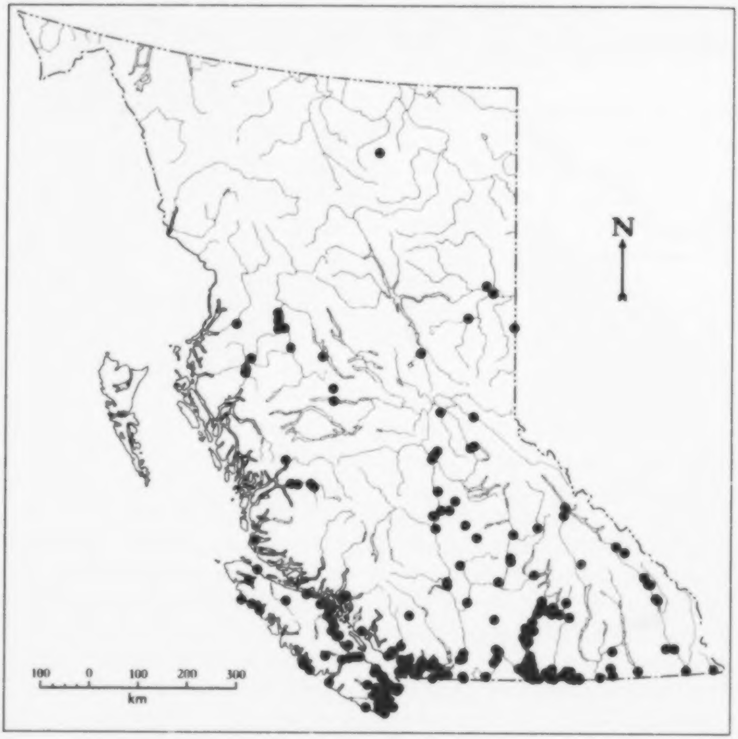
Habits

The Common Garter Snake lives in a wide variety of environments, even in some cities, but is most abundant near marshes, small lakes, ponds and rivers. This selection of habitats appears to be related to the availability of its major prey, amphibians and earthworms, which it eats alive. It also preys on other animals, such as intertidal and freshwater fishes, leeches, small mammals and small birds. The Common Garter Snake is the only snake in British Columbia that eats the toxic Rough-skinned Newt. When captured, this snake sometimes bites but more often emits excrement and strong-smelling fluid from the cloacal glands.

In winter, large numbers of Common Garter Snakes congregate in communal dens, especially in the northern parts of its range, where suitably deep hibernating sites are uncommon. Large dens in British Columbia can hold hundreds of snakes, sometimes including other species, such as the Western Garter Snake. Communal dens become the sites of spectacular mating displays when snakes emerge from hibernation in spring. In milder climates, such as on Vancouver Island, snakes do not need to go very deep underground to survive the winter. Because more sites are available in these areas, all three species of garter snakes hibernate alone or in smaller groups.

Breeding

The Common Garter Snake bears live young in mid to late summer. In British Columbia, litter sizes range from 2 to 22, and



newborns measure 145 to 220 mm in snout-vent length, with considerable variation between populations. Mating usually takes place in spring, following emergence from hibernation, but occasionally in fall. Courtship, as in many snake species, involves attraction of the male to the female by odour, and stimulation of the female by physical contact along the length of the body. Sometimes several males court the same female at the same time, coiling around her to form what looks like a ball of snakes, but only one male succeeds in mating with her. The female can mate again, so that two or more males father offspring in the same litter.

Subspecies: Eleven are recognized, three occurring in British Columbia. The Valley Garter Snake (*Thamnophis sirtalis fitchi*) of the interior of the province has a slaty or brownish background colour, a broad dorsal stripe with well-defined borders, and prominent red bars on the side of the body. The top of the head is black and the sides of the head are red. In eastern British Columbia, the Red-sided Garter Snake (*T. s. parietalis*), also has prominent red bars on the side of the body, but the top of the head is usually olive. On the coast, the Puget Sound Garter Snake (*T. s. pickeringii*) has a relatively narrow dorsal stripe, confined mostly to the mid-dorsal row of scales. The red bars on the side of the body are often small, faint or absent, especially on Vancouver Island specimens; the top of the head is usually black. But these colour variations can occur to some extent in all three subspecies, making them difficult to distinguish.

Range

The Common Garter Snake is the most widely distributed snake in North America, ranging from the Atlantic to the Pacific oceans and from the Gulf of Mexico to near Fort Smith in the Northwest Territories. It is absent, though, from the southwestern United States. In British Columbia, the Puget Sound Garter Snake is restricted to Vancouver Island and the immediately adjacent mainland coast, the Valley Garter Snake occupies most of the range in the province as far north as Hazelton and the Nass River, and the Red-sided Garter Snake occurs from the Peace River district from Fort Nelson south along the extreme eastern side of the province.

Selected References: Charland 1995, Fitch 1999, Gregory 1984, Gregory and Larsen 1996, Gregory and Nelson 1991, Rossman et al. 1996.

Northwestern Garter Snake

Thamnophis ordinoides

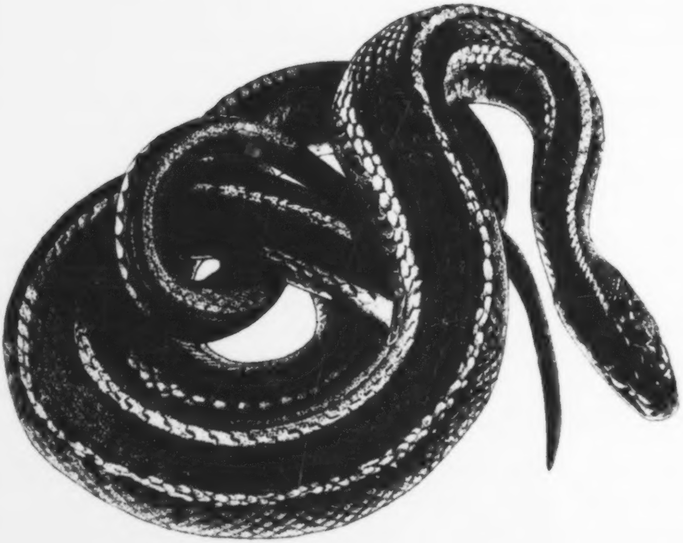
Other Names: Red Racer, Red-striped Garter Snake.

The Northwestern Garter Snake is the most terrestrial of our garter snakes, active in daytime, frequently abundant and often seen in the open. It is a familiar snake to people living in its range, although not always easy to identify.

Description

Northwestern Garter Snakes can reach 355 to 750 mm in snout-vent length, though usually less than 600 mm, and 455 to 960 mm in total length; females are larger than males. The small head is not very distinct from the neck. The snout is blunt; the eye is small and has a round pupil; the upper lip is usually white. There are one or two preocular scutes, and usually seven upper-labial and eight or nine lower-labial scutes. The body scales are strongly keeled and arranged in 17 rows at mid-body. There is a single anal plate. The colours and patterns on Northwestern Garter Snakes vary greatly. Most have a yellow dorsal stripe and a yellow lateral stripe on the second and third rows of body scales on each side, running the length of the body. The background colour is brown with two rows of small black blotches between the stripes; the top of the head is brown, and the upper lip, chin and ventral surface are white. Some small snakes are reddish. Any or all of these features can vary from one individual to another. Some lack dorsal or lateral stripes or both, or have incomplete stripes. The sides of the body may be reddish and the dorsal stripe red; the ventral surface is commonly blotched with red. Dark individuals are fairly common; some are completely black (melanistic), including the eyes, save for a bright-red dorsal stripe or belly or both. Albinos have also been found. Red Northwestern Garter Snakes are sometimes called Red Racers. See colour photographs 51 to 54.

Distinguishing Features: The white upper lip and small, blunt-nosed head. This snake sometimes resembles one of our other two species of garter snakes. Any garter snake that has no stripes or has red blotches or spots instead of bars on any part of the body is likely to be a Northwestern Garter Snake. Small reddish individuals can superficially resemble Sharp-tailed Snakes.



Habits

The Northwestern Garter Snake is highly terrestrial and common in open areas, such as meadows, and along the edges of forests. It also inhabits lightly forested areas and the edges of estuaries and coastal beaches. Although sometimes found near water, this snake does not usually enter the water. In British Columbia, its diet consists of slugs and earthworms.

This garter snake is often the most common snake where it occurs in British Columbia. It is inoffensive and rarely bites when captured; instead, it often emits a strong-smelling fluid from the cloacal glands.

The variable colour patterns of Northwestern Garter Snakes are genetically correlated with anti-predator behaviour. Striped snakes are more likely to attempt to evade predators by flight – the moving stripe apparently makes it difficult for the predator to focus on the snake. By contrast, unstriped snakes more often stop and reverse direction after a short flight, using their camouflage to evade the predator. Like our other two garter snakes, the Northwestern Garter Snake hibernates in communal dens, especially in the colder parts of its range.

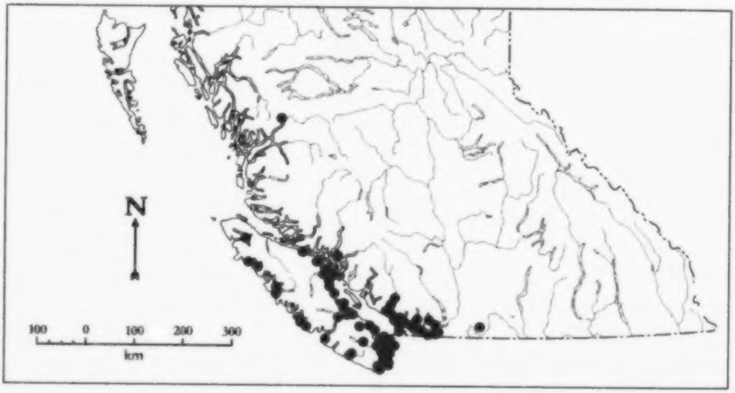
Breeding

The Northwestern Garter Snake mates in both fall and spring, and females bear live young in mid to late summer. On Vancouver Island the litter size varies from 2 to 19. Newborn snakes measure 110 to 150 mm in snout-vent length.

Subspecies: None.

Range

The Northwestern Garter Snake occurs in coastal British Columbia, western Washington and Oregon, and extreme northwestern California. In British Columbia, it is found along the southwestern coast, including the Gulf Islands and all of Vancouver Island, inland to Manning Park, and north up the coast to to an isolated record at Kimsquit, on the Dean Channel.



Selected References: Brodie 1989, 1992; Gregory 1984; Hebard 1951; Rossman et al. 1996.

Western Garter Snake *Thamnophis elegans*

Other Names: Terrestrial Garter Snake, Wandering Garter Snake, Water Snake, Western Terrestrial Garter Snake.

Most current field guides refer to this species as the Western Terrestrial Garter Snake. Although mainly terrestrial populations of this species are known, especially further south in the United States, this species is usually associated with water in British Columbia and other parts of its range, so the Western Garter Snake is a more appropriate name. Next to the Common Garter Snake, this is our most widely distributed snake. Its moderately large size and daytime activity make the Western Garter Snake a familiar species to many people living in its range.

Description

In British Columbia, Western Garter Snakes can grow up to 750 mm in snout-vent length and 960 mm in total length, occasionally longer; females grow larger than males. The head is large and distinct from the neck. The eye is moderately large with a round pupil. The preocular scute is usually single on the coast and double east of the Coast Range. There are usually eight upper labial and ten lower labial scutes, but sometimes seven and nine, respectively; the posterior upper labials are much larger than those of other garter snakes. The body scales are strongly keeled, with 21 rows at mid body and the anal plate is single. The body's background colour is usually grey, black or dark brown on Vancouver Island and lighter brown elsewhere in British Columbia. This snake has a prominent yellow-to-orange mid-dorsal stripe along the length of the back, usually wavy but sometimes straight. Yellow lateral lines run the length of the body on the second and third rows of body scales, but are less evident than the mid-dorsal stripe. There are two rows of dark brown or black blotches between the stripes on each side of the body. The upper row of blotches invades the mid-dorsal stripe, giving the stripe its wavy appearance. These blotches are particularly obvious in interior populations, but may be indistinct in darker coastal populations. A series of small, dark-brown or black spots run below the lateral stripe and may overlap the stripe. The top of the head is black or brownish with black markings in coastal populations, and brown in interior populations. The upper lip is white or yellow. The ventral surface is usually greyish, sometimes with black markings, and the chin and throat are whitish. Some individuals on the coast have a bluish appearance with an otherwise normal pattern. See colour photographs 55 to 57.

Distinguishing Features: This species is most likely to be confused with our other two species of garter snakes. In the interior of British Columbia, it can also be mistaken for a small Gopher Snake or another species with blotched patterns, especially if it has faint stripes. Most Western Garter Snakes have a wavy or zigzag dorsal stripe that readily distinguishes it from our other garter snakes, but snakes with straight stripes should be examined more closely for correct identification. In the interior, the Common Garter Snake is much blacker than the Western Garter Snake. Rules for identifying this species in British Columbia may not apply elsewhere in its range because of geographic variations in colour and pattern.

Habits

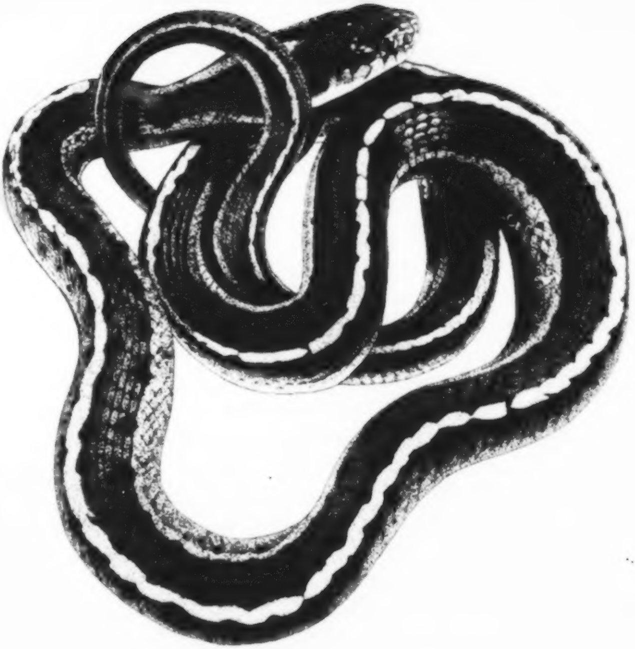
In British Columbia, the Western Garter Snake rarely ventures far from water, either fresh or marine. In some areas, people refer to it as a Water Snake. It is rare in forested areas, but common in open habitats such as meadows and estuaries. This garter snake has one of the most varied diets of any of our snakes. It feeds mainly on slugs, small mammals and fishes, but takes a variety of other prey as well. In coastal areas it eats freshwater and marine fishes. Intertidal fishes may be the predominant food item in some locations. It also eats amphibians, earthworms, leeches, birds and other snakes. The Western Garter Snake subdues an adult rodent by coiling its body around the prey in the manner of a constricting snake. This behaviour is probably not actual constriction but a method of restraining the prey. No other garter snakes are known to do this.

The Western Garter Snake may bite when captured or, like many other snakes, emit a foul-smelling liquid from its cloacal glands.

Like the other species of garter snake in British Columbia, the Western Garter Snake hibernates communally in colder areas, sometimes with Common Garter Snakes.

Breeding

The Western Garter Snake bears live young in mid to late summer. In British Columbia, the litter size varies from 3 to 24 and newborns measure 118 to 212 mm in snout-vent length. Mating takes place in the spring, often at or near hibernation sites.

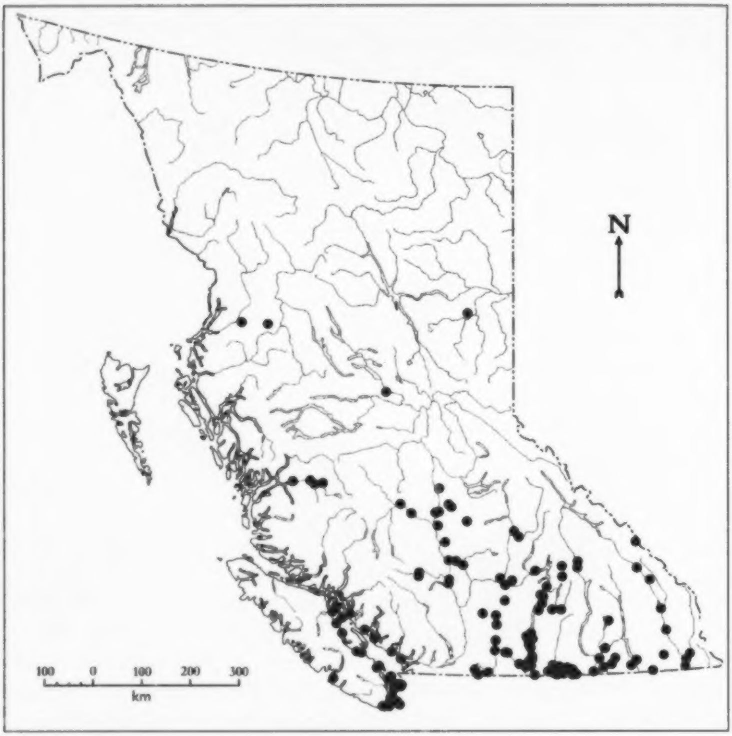


Subspecies: Four are recognized, but only the (Intermountain) Wandering Garter Snake (*Thamnophis elegans vagrans*) occurs in British Columbia. Some authorities consider Vancouver Island populations to represent another subspecies (*T. e. nigrescens*).

Range

The Western Garter Snake ranges from southern British Columbia, southern Alberta and southwestern Saskatchewan to central New Mexico and central California, with only a few gaps in its distribution. It is found throughout the southern half of British Columbia, from Vancouver Island to the Alberta border and as far north as Chetwynd in the Peace River district and the Nass River on the coast. (Map on following page.)

Selected References: Charland and Gregory 1995, Farr 1988, Gregory 1984, Rossman et al. 1996, Waye 1999.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Western Garter Snake distribution.

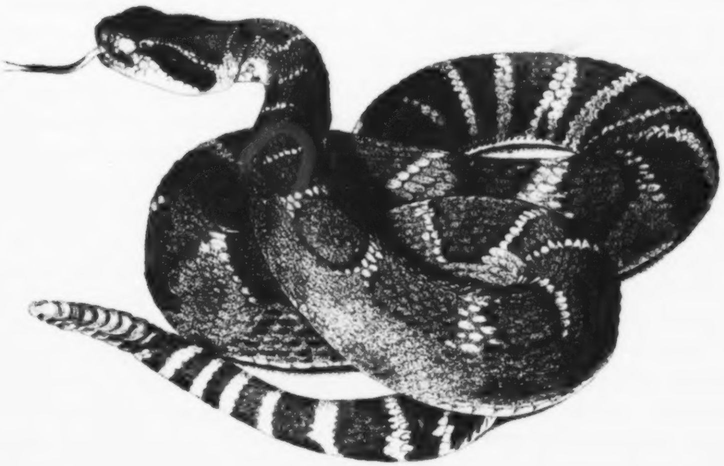
Western Rattlesnake *Crotalus oreganus*

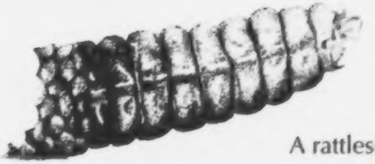
Other Names: Northern Pacific Rattlesnake.

The rattlesnake is British Columbia's only truly venomous snake. Although it can be harmful to humans, this snake is not aggressive if left alone, preferring to retreat from danger, and generally avoiding areas frequented by humans. Until recently, the Western Rattlesnake was considered a subspecies of *Crotalus viridis*, which has now been split into two species. Published references to C. *viridis* before 2001, discussing populations in British Columbia, are about this species.

Description

The Western Rattlesnake has a robust body and short tail ending in a horny rattle or button. In British Columbia it can reach nearly 1200 mm in snout-vent length and 1285 mm in total length, though usually less than 1000 mm and 1070 mm, respectively; males grow larger than females. The head is broad, triangular, and distinct from the neck. The eye is moderate in size with a vertical pupil. A thermosensory organ sits in a cavity or pit between the eye and the





A rattlesnake's rattle.

nostril on each side of the head. The scutes on top of the head are small and there are two preocular scutes. This snake has strongly keeled body scales, a single anal plate and a single row of subcaudal scutes. The body's background colour is brown, tan, olive-green or grey, with a series of large dark-brown blotches along the back. These blotches typically have light-coloured edges and appear as distinct cross-bands on the posterior part of the body and tail. A series of smaller blotches runs along each side of the body below the large blotches. The colour between bands can be somewhat lighter towards the tail than on most of the body. Juvenile rattlesnakes are usually lighter in colour and show a greater contrast of blotches against the background colour than adults. The top of the head usually shows the background colour with a dark band running from below the eye to the corner of the jaw. The underparts are yellowish-white, sometimes brownish. See colour photograph 60.

Distinguishing Features: The rattle most obviously distinguishes this snake from all others in British Columbia, especially the characteristic noise it makes when the snake is disturbed. But the rattle can be small or even missing, so identification should not be based on this character alone. Other important traits are the wide triangular head, the large dorsal blotches that become cross-bands at the rear of the body and the snake's striking position when it is cornered. Rattlesnakes are best left alone.

Habits

The Western Rattlesnake is the only dangerously venomous snake species in British Columbia. Rattlesnakes receive their common name from the series of loosely interlocked horny segments at the tip of the tail, which produces the characteristic rattling or buzzing sound when vibrated rapidly. The rattle's function is not clear, but rattlesnakes typically use it when disturbed, thereby warning intruders of their presence. In newborn rattlesnakes, the rattle consists of a single segment called a button. A new segment is added each time the snake sheds its skin, the button remaining at the tip. In British Columbia, depending on age and sex, rattlesnakes shed once or twice a year, so the rattle lengthens fairly rapidly with age. But the rattle is fragile and segments tend to break off as it becomes longer. Older rattlesnakes rarely have a complete rattle.

The rattlesnake's venom-injecting apparatus likely evolved as a means of catching prey without being injured, but it also injects digestive enzymes directly into the prey, which it swallows whole. These enzymes speed digestion, especially useful when the prey is large. The venom for each fang is produced in a gland above the angle of the jaw and delivered to the fang through a connecting duct. The venom is a complex of chemicals, with some components that destroy proteins and others that interfere with the nervous system. The fangs – two specialized teeth at the front of the upper jaw – act like small hypodermic needles and inject the venom deep into the prey. When not in use, the long fangs fold back along the roof of the mouth. As the snake strikes, they swing forward from their resting position. A rattlesnake takes less than a second to bite. It is impossible to permanently defang a rattlesnake, because the snake produces new teeth throughout its life to replace the ones it loses – a new set of fangs is ready to swing into action as soon as the current ones are lost. Attempting to remove the venom glands usually causes infection or injury to the snake. Like other snakes, rattlesnakes usually take live prey, but sometimes eat carrion; most captive rattlesnakes learn to feed on dead prey.

Rattlesnakes also use their venom for defence. It is dangerous to humans, so rattlesnakes should be treated with extreme caution, but not be mercilessly slaughtered, because they can easily be avoided. When in known rattlesnake habitat, always watch where you put your feet and hands. Wear long, loose trousers to minimize the possibility of a serious bite on the leg; the cloth may absorb some of the venom or even prevent the fangs from reaching the skin. Rattlesnakes are generally not aggressive and usually bite only as a last resort or when startled.

The effect of a snake bite on someone depends on the person's size, health and physical characteristics, the snake's size, how much venom the snake injects, the location of the bite on the body, and how deeply the teeth penetrate. A bite can seriously harm a small child, and a bite directly into a large blood vessel in an adult can be particularly dangerous, because the venom will spread rapidly throughout the body. But few people die of snakebites in North America – bees and wasps account for more fatalities every year than rattlesnakes. Authorities disagree on the most appropriate first aid for a snakebite – some suggest that no first aid should be given unless the victim is far from a hospital. In any case, the victim should be kept calm and still to reduce blood circulation and taken as rapidly as possible to the nearest hospital. Most hospitals in rattlesnake areas have a ready supply of antivenin and medical staff familiar with the treatment of snakebites. Prompt medical care can save the life of a person suffering from a severe snakebite, but the bite may cause local tissue damage, disfigurement or paralysis, and sometimes a bitten limb needs to be amputated.

The Western Rattlesnake keeps to dry habitats with some shelter from the summer sun, typically talus slopes in sagebrush and lightly forested country. In winter, rock outcrops and talus slopes provide dens in which the snakes hibernate underground below the frost line. Rattlesnakes often hibernate communally in groups of up to a hundred or more and share their dens with other species of snakes. They usually go into hibernation in late September and emerge in April. In summer, rattlesnakes are mainly active at twilight, but can be found at any time of day or night in suitable conditions.

Rattlesnakes in British Columbia feed mainly on small mammals, and occasionally on birds. Thus, these snakes are important controllers of rodent pests. The benefits that rattlesnakes provide in this regard more than outweigh the relatively minor hazard they pose to unwary humans.

The pit between the eye and nostril, which is common to all the pit vipers, functions as a heat-sensing organ to help detect the snake's warm, endothermic prey. It is especially useful at night: because the two pits face forward, rattlesnakes can locate prey accurately, in much the same way that humans use binocular vision.

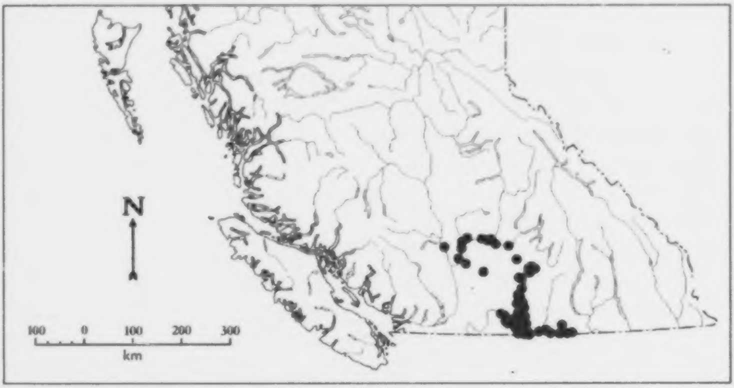
Breeding

Unlike other snakes in British Columbia, the Western Rattlesnake mates in late summer and early autumn. Females do not produce young every year, but at two-year, three-year or longer cycles. The length of the interval depends on the female's foraging success and weight gain over summer. Rattlesnakes live relatively long for snakes: females in British Columbia mature in five to seven years, late in life compared to many of our other snakes. Rattlesnakes bear live young in litters of two to eight, usually in September at or near the overwintering dens. Newborns average 270 mm in snout-vent length.

Subspecies: Six are recognized. Only the Northern Pacific Rattlesnake (*Crotalus oreganus oreganus*) occurs in British Columbia.

Range

The Western Rattlesnake is found west of the Rocky Mountains from southern British Columbia to Baja California except for the driest deserts of the southwestern United States and the wet forests of the northwest. In British Columbia, this species is restricted to the southern dry interior with a range similar to those of the Racer and Gopher Snake. It is found as far west as Lytton, north to Cache Creek and Kamloops, all through the Okanagan region, and east to the Christina Lake area.



Selected References: Ashton and de Queiroz 2001, Blood 1993b, Charland and Gregory 1990, Charland et al. 1993, Macartney 1989, Macartney and Gregory 1988, Macartney et al. 1990.

Introduced and Other Species

Non-native amphibians or reptiles have occasionally been introduced, either intentionally or accidentally, into British Columbia. Three species – the Bullfrog, Green Frog and Common Wall Lizard – have established breeding populations in the province. These species have already been discussed in the species accounts in this book. But other species of amphibians and reptiles have also been introduced into British Columbia, as well as species that could reach this province naturally.

The oceanic ranges of marine turtles can span thousands of kilometres, so it is not surprising that species in the North Pacific sometimes wander into our waters. We rarely encounter these turtles, though, because they breed in the tropics and tend not to come ashore in British Columbia. We know of their presence only from occasional captures in fishing nets, possibly disoriented individuals coming ashore and carcasses washed ashore. The Leatherback Sea Turtle and Green Turtle, which we have described in species accounts, are the only two marine species recorded so far for British Columbia, but at least two other species may stray into our waters. The Olive Ridley (*Lepidochelys olivacea*) occurs off Washington, and carcasses have washed ashore in Alaska, so it is quite likely that it does enter our waters and may be reported in the future. The Olive Ridley has a wide, heart-shaped carapace with a distinctive dorsal keel and has distinctively serrated plates along the outer margins at the posterior end of the carapace. Its carapace is olive-green in colour and the plastron is whitish-green.

A second species, the Loggerhead (*Caretta caretta*), has been recorded twice off the coast of Alaska and hence is also likely to occur in British Columbian waters. The elongated reddish-brown carapace of the Loggerhead can be up to 213 cm long and sometimes tinged with olive. It is serrated at the posterior end, especially in juveniles, and has a mid-dorsal keel that is also serrated at the rear, but the keel serration becomes less obvious with age. The yellowish plastron has two longitudinal ridges, which also become less prominent with age. The head is reddish-brown, and the limbs and tail are brown medially and yellow elsewhere. The scutes on the head and carapace often have yellow borders.

An exotic freshwater turtle that has become abundant in parts of southern British Columbia in recent years is the Pond Slider

(*Trachemys scripta*), especially the famous Red-eared form (*T. s. elegans*) that has long been a mainstay of the pet trade. Large and small Pond Sliders can often be seen basking on logs in southern ponds and lakes, having been released by their owners or escaped from them. Apparently, Pond Sliders have not bred successfully in the wild in British Columbia, but the large number of captive turtles represents a continuing potential source of new animals to compensate for lack of reproduction. This is a conservation concern, because Pond Sliders are similar in size and habits to native Painted Turtles and, therefore, may compete with them or spread diseases, much to the detriment of native species. Young Pond Sliders are easily recognizable by their greenish shells with reticulated markings, yellow stripes on legs, head and tail, and the bright red stripe behind each eye that gives them their common name. Older Pond Sliders usually retain the yellow and red stripes, but become darker in colour.

The Snapping Turtle (*Chelydra serpentina*) is common in eastern Canada. In 1913, six were released at Woodward's Landing, south of Vancouver, and one of these (presumably) was collected ten years later near Steveston, west of Woodward's Landing. None have been seen since in that area, but they occasionally turn up elsewhere, including Vancouver Island, most likely pets that have escaped or been released. The Snapping Turtle is distinctive and easily identifiable: large, big-headed and mud-brown, weighing up to 13.5 kg, with a carapace that can be up to 470 mm long. Its snout is pointed and its upper jaw is hooked. Its neck is long when extended. Its tail is more than half the length of the carapace, or longer in hatchlings, and has a saw-tooth crest of bony tubercles along its length. The carapace has three longitudinal rows of keels, which are usually worn down in large adults. The plastron is cross-shaped and small, compared to the carapace, preventing the turtle from withdrawing its head and legs into the shell. Except for females laying eggs, the Snapping Turtle is seldom found far from marshes, ponds, lakes and slow-flowing rivers, but it occasionally basks above the water surface. This appropriately named turtle is pugnacious and potentially dangerous when disturbed, especially on land, so keep out of the reach of its powerful jaws; larger turtles are best handled by grasping them at the base of the tail. Although Snapping Turtles feed on aquatic vegetation and carrion, they can be voracious carnivores, eating fishes, frogs and other aquatic animals.

Although other exotic reptiles turn up occasionally in British Columbia, the only published record seems to be for the Asiatic Turtle (*Chinemys reevesi*) collected at McCoy Lake, near Port Alberni, in 1929. This small aquatic species has a carapace length rarely exceeding 100 mm. The carapace, head, limbs and tail are brownish, with light markings on the head; the plastron is yellow with dark spots. The carapace has three longitudinal keels. It is possible for a viable population of this species to persist on Vancouver Island, because it occurs naturally in temperate-zone regions of China and Japan. No recent records are known.

Reptiles that are popular in the pet trade, other than Pond Sliders, often turn up as escapees in various parts of British Columbia. The King Snake (*Lampropeltis getula*) has appeared several times in Victoria and elsewhere. Other notable exotics include a European Pond Terrapin (*Emys orbicularis*), and a Speckled Rattlesnake (*Crotalus mitchellii*) that apparently hitched a ride on a recreational vehicle from Arizona to Nanaimo.

Apart from introduced or escaped exotic species, there is also a possibility that other, naturally occurring species of amphibians or reptiles will be found in British Columbia as our herpetofauna becomes better known. Two recent discoveries are the Coeur d'Alène Salamander and the Night Snake, which we have discussed in individual species accounts. Other species that occur in Washington State are known to range to within a short distance of the Canadian border and, therefore, may already occur in British Columbia. These include the Cascades Frog (*Rana cascadae;* see colour photograph 25.), Western Fence Lizard (*Sceloporus occidentalis*), Side-blotched Lizard (*Uta stansburiana*) and Ringneck Snake (*Diadophis punctatus*).

Sometimes, new species appear simply because recent taxonomic work has shown them to be distinct. This happened for the Oregon Spotted Frog (*Rana pretiosa*) and Columbia Spotted Frog (*R. luteiventris*), which were formerly considered members of the same species. Similarly, the Coastal Tailed Frog (*Ascaphus truei*) and Rocky Mountain Tailed Frog (*A. montanus*) have only recently been differentiated, as have the Wandering Salamander (*Aneides vagrans*) and Clouded Salamander (*A. ferreus*).

Selected References: Green et al. 1996, Green et al. 1997, Hayes and Jennings 1986, Hodge and Wing 2000, Jackman 1998, Kiesecker and Blaustein 1997, Lacey et al. 1996, Lardie 1963, Neilson et al. 2001, Wiese 1990, Wilson et al. 1989.

APPENDIX: CONTACT INFORMATION

We would like to know if you encounter a species not known to occur in British Columbia or in an area where it has not been previously recorded. Before contacting anyone listed on the following pages, please consult a field guide and confirm your identification with someone familiar with herpetofauna in the area, such as a local naturalist or a Ministry of Environment conservation officer. They will know whether it's better to report the specimen immediately (e.g., report carcasses found of marine turtles, Pigmy Short-horned Lizards or Night Snakes) or send in your observations on a data form, available from these websites:

www.bcreptiles.ca
www.env.gov.bc.ca/wld/frogwatch/report.htm
www.env.gov.bc.ca/cdc/contribute.html
www.bcwf.bc.ca/programs/wetlands/wetlandkeepers.html

Many naturalists and herpetologists in British Columbia are capable of identifying specimens; the few listed here shared information with us for generating the maps in this book. In order to maximize conservation efforts for amphibians and reptiles and their habitats, it is vital to share details on their occurrences so that we can track populations reliably over time. Hoarding information does nothing to enhance management decisions directed toward the animals and their habitats. If you know of individuals or organizations holding information that would be useful to monitoring common or rare species, please encourage them to share it with those who deal with conservation and management. This information can be sent to the B.C. Ministry of Environment's Conservation Data Centre or B.C. Frogwatch, or to Brent Matsuda (via the websites above or to the addresses on the following pages).

General Contacts

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Herpetofauna Biologist
Ministry of Environment
P.O. Box 9338, Station Prov. Govt.
Victoria, B.C., V9W 9M1
Tel: (250) 387-9755
Fax: (250) 356-9145

B.C. Conservation Data Centre
Ecosystems Branch
Ministry of Environment
P.O. Box 9993, Station Prov. Govt.
Victoria, B.C., V8W 9R7
cdcdata@victoria1.gov.bc.ca
www.env.gov.bc.ca/cdc/

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www.royalbcmuseum.bc.ca

Canadian Amphibian and Reptile
Conservation Network (CARCNet)
info@carcnet.ca
www.carcnet.ca

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Fax: (250) 655-4697
kovaska@jdmicro.com

B.C. Ministry of Environment Endangered Species Contacts in Each Region

Vancouver Island
2080-A Labieux Road
Nanaimo, B.C.
V9T 6J9
Tel: (250) 751-3100
Fax: (250) 751-3208

Lower Mainland
10470 152nd Street
Surrey, B.C.
V3R 0Y3
Tel: 604-582-5200
Fax: 604-930-7119

Thompson
1259 Dalhousie Drive
Kamloops, B.C.
V2C 5Z5
Tel: (250) 371-6200
Fax: (250) 828-4000

Kootenay
401 – 333 Victoria Street
Nelson, B.C.
V1L 4K3
Tel: (250) 354-6333
Fax: (250) 354-6332

Cariboo
Ste. 400 – 640 Borland Street
Williams Lake, B.C.
V2G 4T1
Tel: (250) 398-4530
Fax: (250) 398-4214

Skeena
Bag 5000, 3276 Alfred Aveue
Smithers, B.C.
V0J 2N0
Tel: (250) 847-7303
Fax: (250) 847-7728

Omineca
4015 18th Avenue
Prince George, B.C.
V2N 1B3
Tel: (250) 565-6135
Fax: (250) 565-6940

Peace
400 – 10003 110th Avenue
Fort St John, B.C.
V1J 6M7
Tel: (250) 787-3411
Fax: (250) 787-3940

Okanagan
102 Industrial Place
Penticton, B.C.
V2A 7C8
Tel: (250) 490-8200
Fax: (250) 490-2231

GLOSSARY

adpress To press closely against; with salamanders, the relative length of the limbs can be assessed by holding them closely against the side of the body and checking the distance separating them or the amount they overlap.

aestivate To lie dormant during the summer, usually during periods of unfavourable conditions (e.g., hot, dry).

amniote A vertebrate animal that produces an amniotic egg, allowing it to exploit a terrestrial habitat for reproduction (e.g., reptiles, birds, mammals).

amniotic egg An egg in which the developing embryo is bathed in fluid that is completely enclosed by a membrane called the amnion.

amphisbaenians A group of burrowing, usually limbless, tropical reptiles related to lizards.

amplexus The mating embrace where the male grasps the female with his forearms, either behind her arms (pectoral or axillary amplexus) or around her waist (pelvic or inguinal amplexus).

anamniote A vertebrate that does not have an amniotic egg stage; the egg must be kept moist to keep from drying out. Amphibians and fishes are anamniotes.

antivenin A serum containing antibodies against the venom of a particular snake.

autotomize To reflexively cast off a body part (e.g., the tail in many lizards), usually in response to a predator attack.

behavioural thermoregulation Maintenance of a relatively stable body temperature by behavioural, rather than metabolic means; e.g., snakes and lizards reduce variation in their body temperature by moving back and forth between sunny and shady places; such temperature regulation is effective only under a fairly narrow range of environmental conditions.

bridge The part of a turtle's shell that connects the carapace and plastron.

carapace The upper part of a turtle's shell.

cloaca The common internal cavity for the intestinal, urinary and genital tracts in reptiles and amphibians, opening to the outside via the vent.

constriction The method in which some snakes kill their prey, by coiling around it and compressing it; the prey usually dies from suffocation or heart failure.

costal grooves Vertical grooves on each side of a salamander's body.

crepuscular Active at twilight.

cryoprotectant A substance that protects cells or tissues against damage due to freezing.

dermal Pertaining to the inner layer of skin of vertebrates.

diurnal Active during the daytime.

dorsal Pertaining to the back of an animal.

dorsolateral fold A glandular ridge of skin along the junction between the back and the side in certain ranid frogs.

ectotherm A vertebrate animal dependent upon the warmth of its surroundings (e.g., air temperature, solar radiation) and unable to maintain a constant body temperature by its own metabolic regulation (e.g., a reptile, amphibian or fish), thus body temperature varies with the temperature of the surroundings; also known as a poikilotherm or cold-blooded animal.

endotherm A vertebrate animal that generates its own metabolic heat (e.g., a bird or mammal) so that its body temperature remains constant regardless of the surrounding temperature; also called a homeotherm or warm-blooded animal.

envenomation The method in which some species of snakes (and lizards) kill their prey, by injecting venom, via the fangs, when they bite; also used in defence.

epidermal Pertaining to the outer layer of the skin of vertebrates.

epiglottis Flap of tissue folding over the opening of the windpipe (trachea) in the throat.

gravid Pregnant; bearing eggs or developing young internally.

gular fold Fold of skin running across the throat of salamanders and lizards.

hemotoxin Venom that mainly affects the circulatory system and causes local tissue destruction (e.g., rattlesnake venom).

hemipenes The paired copulatory organs of male squamate reptiles (snakes, lizards, amphisbaenians) located in the base of the tail; only one hemipenis is used in a mating.

herpetofauna Amphibians and reptiles.

herpetology The branch of biology that deals with the study of amphibians and reptiles.

hypothalamus Part of the pituitary gland at the base of the brain.

Jacobson's organ A sensory structure in the roof of the mouth of snakes and lizards that allows it to detect chemicals in the environment (in the air and on the ground) that are picked up by the tongue when it is flicked out; also known as the vomeronasal organ.

kinetic skull In snakes and many lizards, different parts of the skull can move, via joints, in relation to each other – especially the upper jaw in relation to the braincase – enabling the animal to swallow relatively large prey.

labial Pertaining to the lips.

labial teeth Horny teeth arranged in transverse rows on the lips of tadpoles.

laminae (singular: **lamina**) The visible epidermal scutes covering the plates on a turtle's shell.

larva An immature form of an animal that radically differs in appearance from the adult.

metamorphosis The change from a larva to an adult form.

metabolism The collective chemical processes that occur in cells of an organism and result in the production of energy that is used for all activities.

microhabitat Small or limited habitat that differs from the greater environment; an animal's immediate surroundings.

morphology The form and structure of an animal.

nasolabial groove A fine groove running down from the nostril to upper lip of lungless salamanders.

neoteny The condition whereby an animal matures without metamorphosing into a terrestrial form, resulting in a gilled, permanently aquatic, sexually mature individual. This phenomemon occurs under certain environmental conditions in some salamanders, including *Ambystoma* and *Dicamptodon*.

neurotoxin Venom that mainly affects the nervous system (e.g., cobra venom).

nocturnal Active at night.

nuptial pads Black thumb pads that develop on some species of adult male frogs during breeding season.

oviparous Pertaining to animals in which the young develop in eggs laid by the mother; egg-laying.

parasphenoid teeth Rows of teeth on the roof of the mouth, characteristic of plethodontid salamanders.

parotoid gland A large, raised skin gland at the back of the head behind the eye of toads and certain salamanders.

plastron The lower part of a turtle's shell.

poikilotherm Vertebrate whose temperature varies with the temperature of its surroundings.

preocular In the front of the eye.

presacral vertebrae Elements of the backbone anterior to the sacral vertebrae that articulate with the pelvis.

retractile Capable of being drawn back or in.

sacral Pertaining to the sacrum. A frog's sacral hump is where the pelvis meets the backbone.

scute An external horny scale; a large scale or plate on the head or belly of a snake; a large scale or plate on a turtle's shell.

sexual dimorphism Differences between the two sexes of a species in size, colour or other attributes.

snout-vent length The distance from tip of the snout to the vent; a standard measurement of body length in many amphibians and reptiles (e.g., lizards that tend to shed and regrow their tail). See illustrations on pages 71 and 196.

spade A large, horny tubercle on the sole of a burrowing toad's foot.

species A lineage of interbreeding organisms or population of organisms with a unique history, often distinguished by morphological features, although biochemical and genetic information is gaining importance.

spectacle A clear scale that covers the eye of a snake; also called a brille.

spermatophore A small jelly packet or ball containing sperm deposited by male salamanders during mating.

spermatheca The internal sac in female salamanders used to store sperm.

subcaudal scutes The scutes on the underside of a snake's tail.

suctorial Acting like a suction cup.

tetrapod Vertebrates in which the ancestral condition is the possession of four limbs for terrestrial locomotion, although this condition may be modified in subsequent evolution (e.g., in whales, birds, snakes); any vertebrate other than a fish.

thyroid stimulating hormone Produced by the pituitary gland (at the base of the brain), this hormone controls the release of thyroxine from the thyroid gland.

thyroxine Hormone produced and secreted by the thyroid gland (in the neck); it increases the metabolic rate, regulates growth and development, and affects metamorphosis in amphibians.

tubercle A small, knob-like prominence or a raised bump on the skin, but not a poison gland (like a wart).

tympanum The eardrum; in mammals the tympanum stretches between the outer and middle ear, in reptiles and birds more superficially, and in frogs and toads on the surface behind the each eye (though not all frogs and toads have tympanums).

vent The external opening of the cloaca, on the ventral surface at the base of the tail.

ventral On the belly or underside of an animal.

vestigial Diminished, atrophied or functionless from the process of evolution.

viviparous Bringing forth live young that develop within the body of the mother; live-bearing.

vocal sac Inflatable sac under or at the side of the throat in male frogs and toads that acts as a sound resonating chamber.

vomerolfaction Detection of chemicals in the environment via Jacobson's organ; snakes and many lizards deliver the chemicals via their forked tongue.

wart A raised poison-containing gland on the skin of a toad or other amphibian.

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Canada's undisputed snake god is renowned for his grumpy demeanor. Born in England, he moved to Canada at an early age and progressed in stages from Toronto to Winnipeg to Victoria, where he is professor of biology at the University of Victoria. Almost all of his publications are on reptiles, mostly snakes, but he has published a few token papers on amphibians.

Brent M. Matsuda

After serving time at the University of Guelph, this overachieving ectotherm metamorphosed in the Vancouver Aquarium's Amazon Gallery, chased ducks for the Canadian Wildlife Service and became naturalized in Manning Provincial Park. He completed his M.Sc. at UBC in 2001, then was exiled to Davis, California, toiling as an environmental consultant, all the while coordinating this massive book project. He plans to reunite with B.C.'s herpetofauna in the near future.

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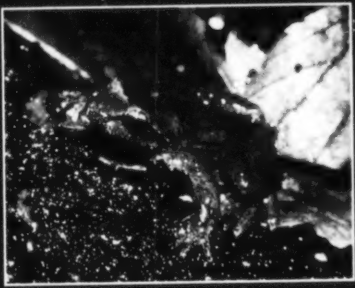

Amphibians and Reptiles of British Columbia combines two popular and respected handbooks that have informed readers in various editions for more than 60 years. This new edition is written in the same easy-to-read style, and is essential for naturalists, biologists and anyone interested in turtles, lizards, snakes, salamanders, frogs and toads.

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